RAILWAY ENGINEERING

AND MAINTENANCE OF WAY.

BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

Vol. VI | *Chicago* | SEPTEMBER, 1910 | *New York* | No. 9

CLASSIFIED INDEX OF ADVERTISERS

Anchors.
Railway Specialties Co., New York.

Asbestos Products. All kinds.
Franklin Mfg. Co., Franklin, Pa.

Asbestos Roofing Slates.
Franklin Mfg. Co., Franklin, Pa.

Asbestos Sheathing.
Franklin Mfg. Co., Franklin, Pa.

Axle Washers.
Hubbard & Co., Pittsburg, Pa.

Ballast Cars.
Rodger Ballast Car Co., Chicago.

Ballast Placing Device.
Rodger Ballast Car Co., Chicago.

Ballast Spreaders.
Mann-McCann Co., Chicago.

Ballast Unloaders.
Rodger Ballast Car Co., Chicago.

Battery Chutes.
L. S. Brach Supply Co., New York.

Bridge Paint.
Dixon, Joseph, Crucible Co., Jersey City.

Bridge Turning Machinery.
Otto Gas Engine Works, Chicago.

Buckets, Automatic Grab.
G. H. Williams Co., Cleveland, O.

Buckets, Excavating.
G. H. Williams Co., Cleveland, O.

Buckets, Dump.
Acme Equipment & Eng. Co., Cleveland.

Bumping Posts.
Mechanical Mfg. Co., Chicago.
Scott & Sons, J. M., Racine, Wis.

Building Felts and Papers.
Franklin Mfg. Co., Franklin, Pa.

Cable Railways.
Wm. J. Haskins, New York City.

Car Pushers.
The Industrial Supply & Equip. Co., Philadelphia.

Car Replacers.
Johnson Wrecking Frog Co., Cleveland, O.

Cars.
Hicks Locomotive & Car Wks., Chicago.

Cars Ballast.
Hicks Locomotive & Car Wks., Chicago.
Rodgers Ballast Car Co., Chicago.

Cars Dump.
Hicks Locomotive & Car Wks., Chicago.
Rodgers Ballast Car Co., Chicago.

Cars Rebuilt.
Hicks Car & Locomotive Works, Chicago.

Cattleguards.
Standard Cattle Guard Co., Birmingham, Ala.

Chisels.
Hubbard & Co., Pittsburg, Pa.

Clam Shell Buckets.
Wm. J. Haskins, New York City.

Clamps.
Railway Specialties Co., New York.

Coal Miners' Tools.
Hubbard & Co., Pittsburg, Pa.

Coal Chutes.
Otto Gas Engine Works, Chicago.

Coal and Ore Handling Machinery.
Rodgers Ballast Car Co., Chicago.
Wm. J. Haskins, New York City.

Coal Pockets and Equipment.
Wm. J. Haskins, New York City.

Concrete Mixers.
Marsh Co., Chicago.

Conveyors.
Wm. J. Haskins, New York City.

Continuous Joints.
The Rail Joint Co., New York.

Contractors' Equipment and Supplies.
Hicks Locomotive & Car Wks., Chicago.

Crossing (See Frogs and Crossings).

Dump Cars.
Rodgers Ballast Car Co., Chicago.

Culvert Pipe Cast Iron
Galion Iron Works Co., Galion, O.

Culvert Pipe Corrugated
Galion Iron Works Co., Galion, O.

Elevators.
Wm. J. Haskins, New York City.

Engineering Instruments.
R. Seelig & Son, Chicago.

Fire Proof Paint.
Detroit Graphite Mfg. Co., Detroit.

Forgings.
Cleveland City Forge & Iron Co., Cleveland, O.

Frogs and Crossings.
Cincinnati Frog & Switch Co., Cincinnati.
Indianapolis Switch & Frog Co., Springfield, O.

Frogs and Switches.
Cincinnati Frog & Switch Co., Cincinnati.
Indianapolis Switch & Frog Co., Springfield, O.

Graphite.
Detroit Graphite Mfg. Co., Detroit.
Dixon, Jos., Crucible Co., Jersey City, N. J.

Hoes.
Hubbard & Co., Pittsburg, Pa.

Hoisting Machinery.
Wm. J. Haskins, New York City.
Brown Hoisting Machinery Co., Cleveland.

Inspection Cars.
Duntley Mfg. Co.
Fairbanks, Morse & Co., Chicago.
Light Inspection Car Co., Hagerstown, Ind.
Mudge & Co., Burton W.

Interlocking Switch Stands.
Foster, Frank M., Columbus, O.

Lamps & Lanterns.
Adams & Westlake Co., Chicago.
Peter Gray & Sons (Inc.), Boston.

Light, Locomotive (See Locomotive Contractors.)

Jacks.
Dayton Iron Wks. Co., Dayton, O.
Fairbanks, Morse & Co., Chicago.
Watson-Stillman Co., New York.

Locomotives.
Cincinnati Equipment Co., Cincinnati, O.
Vulvan Iron Works, Wilkes-Barre, Pa.

Locomotive Cranes.
Brown Hoisting Machinery Co., Cleveland.

Locomotives, Contractors'.
Hicks, F. M., & Co., Chicago.

Locomotives, Second Hand.
Hicks Locomotive & Car Works, Chicago.

Locomotive Replacers.
The Johnson Wrecking Frog Co., Cleveland, O.

Locomotive Water Cranes.
Otto Gas Engine Works, Chicago.

Lubricants (Graphite).
Dixon, Joseph, Crucible Co., Jersey City, N. J.

Mail Cranes.
Burton W. Mudge & Co., Chicago.

Metal Paints.
St. Louis Surfacer & Paint Co., St. Louis, Mo.

Motor Cars.
Duntley Manufacturing Co., Chicago.
Fairbanks, Morse & Co., Chicago.
Mudge & Co., Burton W.

Oil Tanks.
Bowser, S. F., & Co., Ft. Wayne, Ind.

Paints.
Johnston Paint Co., R. F. Cincinnati, O.
Rabok Mfg. Co., St. Louis, Mo.
St. Louis Surfacer & Paint Co., St. Louis, Mo.

Perforated Metal.
Dixon, Joseph, Crucible Co., Jersey City, N. J.

Picks.
Hubbard & Co., Pittsburg, Pa.

Pole Line Material.
Hubbard & Co., Pittsburg, Pa.

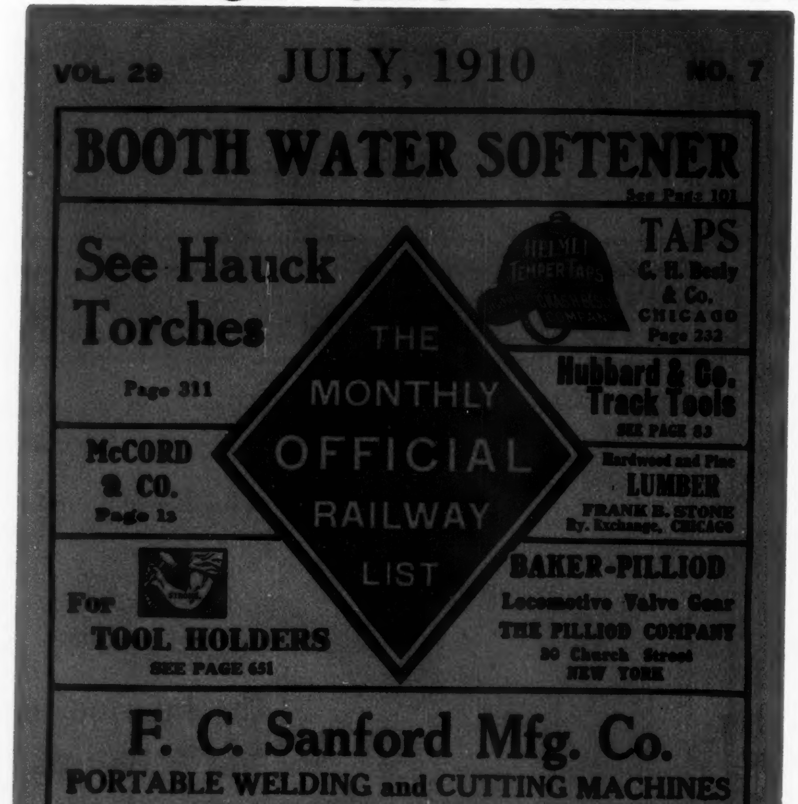
Post Hole Diggers.
Hubbard & Co., Pittsburg, Pa.

Pumps.
Bowser, S. F., & Co., Ft. Wayne, Ind.

Rail Benders.
The Industrial Supply & Equipment Co., Philadelphia, Pa.

Rail Braces.
Indianapolis Switch & Frog Co., Springfield, O.
Rail Drills.
Indianapolis Switch & Frog Co., Springfield, O.
Rail Joints.
The Rail Joint Co., New York.
Railroad Track Tools.
Hubbard & Co., Pittsburg, Pa.
Railway Equipment and Supplies.
The Industrial Supply & Equip. Co., Philadelphia.
Railway Supply Co., St. Louis.
Indianapolis Switch & Frog Co., Springfield, O.
Hicks Locomotive & Car Works, Chicago.
Replacers, Car, and Engines.
The Johnson Wrecking Frog Co., Cleveland, O.
Road Making Machinery
Galion Iron Works Co., Galion, O.
Rock Crushing Machinery
Galion Iron Works Co., Galion, O.
Road Rooters and Plows
Galion Iron Works Co., Galion, O.
Rolling Steel Doors and Shutters.
Adreon & Co., St. Louis, Mo.
Atlantic Equipment Co., New York.
Bird, F. W. & Son, East Walpole, Mass.
Stowell Mfg. Co., Jersey City, N. J.
Roofing Slates and Shingles. Asbestos.
Franklin Mfg. Co., Franklin, Pa.
Rolling Stock.
Hicks, F. M., & Co., Chicago.
Roofing Materials, Asbestos.
Franklin Mfg. Co., Franklin, Pa.
Sand Driers.
J. J. Parkhurst, Chicago.
Second Hand Equipment.
Hicks Locomotive & Car Works, Chicago.
Sheathing, Asbestos.
Franklin Mfg. Co., Franklin, Pa.
Signal Lamps.
Adams & Westlake Co., Chicago.
Signal and Crossing Alarm Material.
L. S. Brach Supply Co., New York.
Shovels, Spades and Scoops.
Hubbard & Co., Pittsburg, Pa.
Signal Specialties.
Brach Supply Co., L. S., New York.
Steam Road Rollers
Galion Iron Works Co., Galion, O.
Stock Guards.
Standard Cattle Guard Co., Birmingham, Ala.
Striking Hammers.
Hubbard & Co., Pittsburg, Pa.
Surveying Instruments.
R. Seelig & Son, Chicago.
Switches and Switch Stands.
American Valve & Meter Co., Cincinnati, O.
Indianapolis Switch & Frog Co., Springfield, O.
Frank M. Foster, Columbus, O.
Tanks and Tank Fixtures.
American Valve & Meter Co., Cincinnati.
Ties.
G. S. Baxter & Co., New York.
Tie Plates.
Spencer Otis Co., Chicago.
Track Jacks (See Jacks.)
Track Layers.
Hurley Track Laying Machine Co.
Track Materials.
Indianapolis Switch & Frog Co., Springfield, O.
Railway Specialties Co., New York.
Track Weeders.
Duntley Mfg. Co., Chicago.
Traction Engines
Galion Iron Works Co., Galion, O.
Turnbuckles.
Cleveland City Forge & Iron Co., Cleveland, O.
Turntables.
Philadelphia Turntable Co. of Phila.
Washers.
Hubbard & Co., Pittsburg, Pa.
Water Columns.
American Valve & Meter Co., Cincinnati.
Water Softening Apparatus.
L. M. Booth Co.
Water Stations.
Otto Gas Engine Works, Chicago.
Water Tanks.
Otto Gas Engine Works, Chicago.
Wedges.
Hubbard & Co., Pittsburg, Pa.
Wrecking Frogs.
The Johnson Wrecking Frog Co., Cleveland, O.
Wrenches.
Coes Wrench Co., Worcester, Mass.

For the Sake of Conven



The present size measures 4½ in. by 8⅛ in., and is approximately ⅝ in. thick. Weight about one pound.

TO THE US HE

Gentlemen:

It has been at T
Railway List is of ma
for some purposes to te
are printing herew ze r
"List" as at present nd o
reproduction show shap
lishers will be plea shou
opinion so demand hank
most interested t ur c
change. We will decisi

Regardless r n
regular issue is aveli
printed without ad and
on the right, will for t
advertisers. This be
weight paper and ature
ular issue, useful t n.

The Rai t C

Pres.

1500 changes are m s of Ra
The Month List eac

en, Which Do You Prefer?

USHE "RED LIST"

een st The Monthly Official
s of h makes it inconvenient
oses to test the case out, we
erewize reproduction of the
esent nd opposite it, a full size
show shape which the pub-
plea should the majority of
mand hank you as the people
ed to ur opinion as to the
will decision of the majority.
less or not the size of the
is caveling men's edition,
ut ad and of the size shown
vill b for the beneft of the
This be printed on light
and atures, not in the reg-
eful th.

Rait Company

, Pres.

s are m s of Railway Officials in
Mont List each month.

The circulation of The Monthly Official Railway List is perfect among Executive, Purchasing, Operating, Mechanical and Engineering Officials of the North American railroads. Circulation books are open to all and proof of number of copies printed each month supplied on request.

This size measures 4 inches by 6 inches, and is approximately 1 inch thick. Weight about one pound.

Contents

Editorial—
Jurisdiction 375
Truth 375
Signal Department 375
Reinforced Concrete Construction 376
Seasoning and Preservative Treatment of Ties 385
American Railway B. & B. Assn. Meeting 393
Report on Electrification 394
Letters 401
Construction 402
Railway Signal Standards, Illinois Central 404
Report of Block Signal and Train Control Board 410
Farmers' Instruction Trains on Pennsylvania 412
Electro-Mechanical Interlocking Machine 412
Hoeschen Highway Crossing Bell 414
The Morgan Frog 416
Hot-Wire System for Tungsten Lamps 417
Land Speaking Telephone 417

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY.
BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK
Published by THE RAILWAY LIST COMPANY

WILLIAM E. MAGRAW, Pres. and Treas.
CHAS. S MYERS, Vice-Pres. C. C. ZIMMERMAN, Bus. Mgr.
NORMAN F. REHM, Editor J. M. CROWE, Mgr. Central Dist.

Office of Publication: 315 Dearborn Street, Chicago
Telephone, Harrison 4948
Eastern Office: 50 Church Street, New York
Telephone, Cortlandt 5765
Central Office: 403 House Bldg, Pittsburg

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.
Communications on any topic suitable to our columns are solicited.
Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.
In remitting, make all checks payable to the Railway List Company.
Papers should reach subscribers by tenth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

Vol. VI. Chicago, September, 1910 No. 9

JURISDICTION.

IT IS ASSERTED by many people, and with considerable justification, that there are too many officials in proportion to the number of men employed on railroads. Perhaps the number would not be excessive were it not for the fact that department lines, even on a strictly divisional road, are very sharply drawn. For example; there certainly would be much hard feeling and probably many personalities passed should a bridge and building foreman or even a master carpenter attempt to give orders to a sectionman. Not only would the section foreman feel outraged, and justly so under our present methods of organization, but his superior, the roadmaster, would undoubtedly feel moved to take the matter up higher. Likewise the signal repairmen cannot be pressed into service by the roadmaster without the consent of the supervisor, and to have a heavy consignment of apparatus moved by the section forces, orders must be obtained from the roadmaster. All this is based upon the theory that each department even on a division must have as its head a specialist on his particular line of work. Now if the theory stopped here and made the specialist a staff officer with power to inspect, instruct and recommend only, and should leave the handling of the men and materials pertaining to maintenance of way and structures in the hands of, say a general foreman, much red tape and friction would be avoided. Getting down to fundamentals, is there any real reason why a section foreman should not know how to maintain signals or repair wooden structures? We cannot expect this of the track laborer, but why could not the section foreman be both foreman of the section gang and bridge gang combined, and signal maintainer? Why not go one step further and give him authority over the pump men and other water service employees? If necessary to employ expert plumbers, carpenters, etc., who can work only at their own trade, let them move from place to place, as they do now, and be under the jurisdiction of the foreman upon whose section they are working. With such a system as this, what a vast amount of red tape would be cut, what a lack of co-operation would be eliminated! We understand that a scheme something like that outlined is being tried out on a large western road. The results should be awaited with considerable interest by all engaged in maintenance of way and structures.

TRUTH

A NEW DEPARTURE in railroad testimony was recently tried out by President Ripley of the Santa Fe before the Interstate Commerce Commission examiners in Chicago. The daily papers had expected the usual plea of increased expenditures due to rise in prices of materials and labor, of poverty and approaching bankruptcy as a reason why rates should be increased. Instead, Mr. Ripley testified, in effect, that his road, for one, was perfectly able to pay its way under present conditions, but that if he was to maintain and operate such a railroad as the people desire and expect in the manner they think it should be run and are inclined to insist upon, then the people must help pay the costs by contributing through higher rates. Such argument, being the absolute and indisputable truth, took everyone by surprise and created an impression more favorable to the railway's case than could have been produced by any other means, and it is greatly to be hoped that the fashion thus set by Mr. Ripley of telling the truth fearlessly will find many followers in the future. The old plea of poverty, and of asking for increased rates as a matter of charity never deserved more respect than it received. By adopting such methods the roads have in the past only laid themselves open to the same treatment at the hands of the public as is accorded to beggars generally.

CHANGE OF MEETING PLACE

THIS MONTH we publish the standards of the Illinois Central, Mr. N. E. Baker, Signal Engineer. This road is noteworthy as being one of the large systems which has not as yet adopted the upper quadrant. Perhaps the most remarkable phenomenon in the history of signaling in America is the rapid adoption of the upper

quadrant. It has been used for new work, has been inserted in the midst of other types, and has supplanted the older types, the signals being converted. To illustrate how quickly the use of the upper quadrant, three position semaphore has spread, four years ago automatic block signals of this type were in practical use i nthis country on one road only. To-day the following roads are among those that have adopted upper quadrant: New York Central, Pennsylvania, Lake Shore, Boston & Albany, Atlantic Coast line, Long Island, Baltimore & Ohio, Rock Island, Frisco, C. M. St. P., North-Western, Great Northern, Northern Pacific, C. H. & D., Nickle Plate, Soo Line, Lehigh Valley, Erie, Santa Fe, Michigan Central.

It is interesting to note that the Illinois Central uses a separate pole line for its signal wires. This practice is by no means uncommon, but yet it is not nearly so common as it should be. It is the only way to get maximum efficiency out of the signal circuits.

See notice of change of meeting place, annual convention American Railway Bridge and Building Association.

A Unique Type of Reinforced Concrete Construction

Theodore L. Condron.*

The most common material used in floor construction for buildings in wood and the usual form of wooden floor construction consists of plank flooring supported on joists, and the latter in turn supported by wooden girders between columns or walls. With the introduction of structural iron and steel, wooden columns, girders and joists have been frequently replaced with iron or steel. It will be noticed that except for the continuity of the plank flooring, there is no continuity in any of the parts of this construction, except that a little may be gained by riveting or bolting together the webs of iron or steel beams, as it is not practical to splice the beam flanges over supports. In special cases plank flooring has been replaced by brick, tile or concrete arches sprung between steel beams, the latter being carried by steel girders.

With the introduction of reinforced concrete as a building material, the familiar forms of floor construction were very naturally reproduced in this material. The gradual development of this construction may be outlined in seven types, thus:

(1) Reinforced concrete slabs, carried by steel joists and girders. Fig. 1†.

(2) Reinforced concrete slabs and joists, carried by steel girders. Fig. 2†.

(3) Reinforced concrete long span slabs, carried by steel girders. Fig. 3†.

(4) Reinforced concrete slabs, joists and girders. Fig. 4†.

(5) Reinforced concrete long span slabs and girders. Fig. 5†.

(6) Reinforced concrete slabs, without beams or girders. Fig. 6.

(7) Reinforced concrete paneled slabs, without beams or girders. Fig. 7.

In the summer of 1907 the writer's partner, Mr. F. F. Sinks, designed and made complete sketches for a new type of reinforced concrete floor construction, eliminating the usual girders and beams.‡ After very carefully analyzing the stresses in this design we decided to make tests to demonstrate the correctness of our analysis. We, therefore, had a model made to one-eighth size of a portion of the first floor of the Manufacturers' Furniture Exchange Building, Fig. 5, reproducing 2¼ panels in width by 2¼ panels in length of the floor construction and columns. Another model was also made of the same proportion and with the same column spacing, but following the girderless slab design referred to. These two models are shown in Fig. 8 as they were set up for testing. The surface area of these models was approximately twenty square feet each. A very simple apparatus was arranged for testing by hydrostatic pressure, the models being supported on heavy steel I-beams, and a testing platform covering the upper surface. Between the testing platform and surface of the model there was introduced a rubber diaphragm filled with water and connected with a stand pipe. By raising and lowering the head of the water in the stand pipe, loads were put upon the model, varying from 0 to 970 lb. per sq. ft. Deflectometers were used to measure the deflection of each of the four panels, by means of which it was possible to measure without difficulty the deflection to a thousandth of an inch. The deflections of these panels were recorded and these records are shown in Fig. 9. The models reproduced construction designed for safe loads of 150 lb. per sq. ft. The dead weight of the floor, in full size, averaged about 85 lb. per sq. ft. hence, the dead load and "safe live load" together equaled 235 lb. per sq. ft. With a factor of safety of three, the theoretical ultimate strength of the construction would, therefore, be 705 lb. per sq. ft. In models of this kind, the carrying capacity of the models should be the same as the carrying capacity of the floor construction, that is, the model although of one-eighth the size should be capable of carrying as much load per square foot as the actual floor and not one-eighth of the load. It is, therefore, interesting to note from the deflection diagrams, that while these models carry with only a few cracks and no sign of collapsing, as much load as we could put on with our apparatus, namely 970 lb. per sq. ft., they show marked changes in the deflection curves after the loads exceed 700 lb. per sq. ft. The study of the tests of the models has been of great assistance in determining the proper method of analysis of the stresses in this construction and also confirmed us in the correctness of our original analysis.

This design comes under the "6th" type, the floor "slab without girders or beams." The first practical application made of this design was in the reinforced concrete construction of a factory building for Hirsh, Stein & Co., at Hammond, Ind., shown in Fig. 6. These floors were designed for a safe working load of 400 lb. per sq. ft. in addition to the dead load. The columns are 15 ft. apart. As the building is used for the manufacture and storage of fertilizer, there was no attempt to make it ornamental. The partial reinforcing of the floors, shown in Fig. 10 indicates the important elements of the design, but these will be made clearer in the illustrations and descriptions of the Studebaker Building which follows. It should be stated, however, that these floors are carrying daily the full 400 lb. live load for which they were designed, and probably this is frequently exceeded. This load is equivalent to the weight of water covering the floor seven feet deep. The photograph, Fig. 6, was taken by the writer when they were beginning to use the floor for piling fertilizer from a belt conveyor.

This brings us to the seventh type of construction, "the paneled slab without girders or beams," a type especially suited to business and factory building and adopted for the construction of the Studebaker Building at the corner of Michigan Ave., and 21st St., Chicago.

This building was erected by Wm. Grace & Co. for the owner, Mr. D. M. Cummings, and is occupied by the Stu

---

‡Mr. Sinks has applied for letters patent covering the construction here described.

---

*Read before the Western Society of Engineers.

†Brief descriptions of the illustrations of these five types are given in the appendix to this paper.

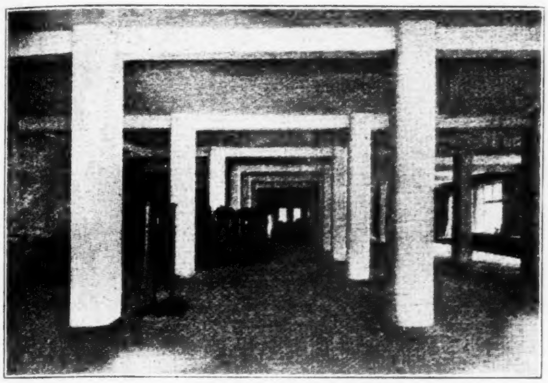


Fig. 1.

baker Bros. Mfg. Co., for the sale, storage, and repair of automobiles. The Standard Concrete Construction Co. were sub-contractors for the concrete work. The reinforced concrete portions of this building were designed by the writer's firm as consulting engineers for the architect, Mr. William Ernest Walker, of Chicago. The appearance of the exterior is shown in Fig. 11, which is reproduced from the architect's perspective drawing. The building is seven stories high above the sidewalk with a basement 8 ft. 6 in. clear under the ceiling, as shown in Fig. 15. The foundations are concrete caissons carried to bed rock 90 ft. below grade. The first and second stories have practically uninterrupted show windows on the two street frontages while the stories above the second have brick curtain walls trimmed with stone, and broken by groups of large windows. The reinforced concrete wall girders are faced with brick so that no concrete appears on the exterior.

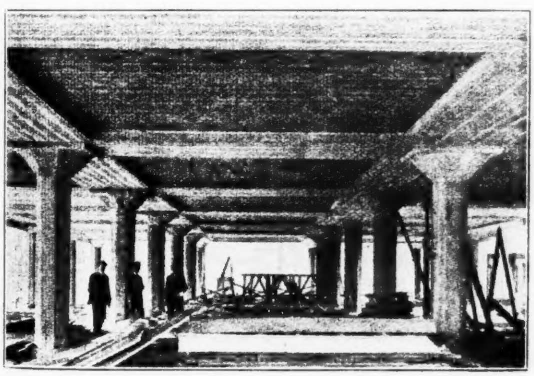


Fig. 2.

The eighth floor forms a temporary roof, provision having been made for continuing the building several stories higher in the future if so desired. A photograph taken on Nov. 4th, Fig. 12, shows the columns, floors, walls and girders completed for four stories and work progressing on the fifth floor.

Typical interior views are shown in Fig. 13 and Fig. 14, being photographs of the basement, and first story, taken just after the forms were removed from under the ceilings. The column spacing, it will be noted, is unusually great, being practically 24 ft. each way, making the diagonal distance between column centers about 34 ft.

The advantages gained by this paneled slab design are:

(1). An improved form of construction whereby great strength and carrying capacity are attained with an economical expenditure for material and labor.

(2). A construction in which the stresses due to dead weight and all applied loads can be accurately determined.

(3). A minimum depth of floor and a consequent reduction in the height of the building.

(4) An improvement of the illumination of the rooms by the elimination of dark ceiling shadows; and

(5). A reduction in the expense of installing a sprinkler system.

The construction consists of continuous and paneled slabs, supported upon flaring column heads. A cross section of the adopted design of this building and also a typical partial section of a design for the same building, using reinforced concrete girders, beams and slabs is shown in Fig. 15. The same clear story heights have been provided in both designs. It will be seen that the excavation for the basement is 1 ft. 6 in. less for the adopted design than for the other and that the height from the sidewalk to the surface of the eighth floor is 93 ft. 8 in. as compared with 104 ft. 2 in. or 10 ft. 6 in. less for the adopted design than for the other. A typical floor plan of the building, Fig. 16, shows the arrangement of the columns, stairs, and elevator openings.

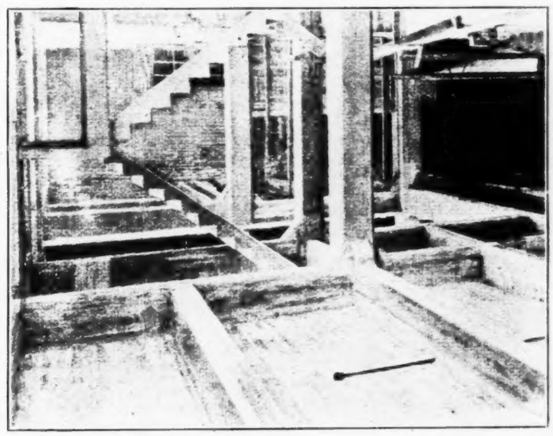


Fig. 3.

In the illustrations, it will be noted the adopted design has columns with widely flaring heads or capitals surmounted by square caps. These column heads and caps support and form a part of a platform or slab, which may either be of uniform thickness or may be paneled, as in this case, to reduce the thickness in the center, but for purposes of calculation and design the floor and ceiling consists of intersecting slabs, having widths equal to, or slightly greater, than the extreme width of the column caps, these intersecting slabs in turn supporting enclosed slabs. In this construction, whether the floor is made of uniform thickness or is made thinner in the center, the manner of reinforcing and supporting it is the same.

This method of reinforcing the floor construction is exceedingly simple and direct, and is clearly indicated in Fig. 17 and Fig. 18. The longitudinal reinforcement of the intersecting slabs consists of ¾ in. and ⅞ in. square steel bars. These bars are bent as shown in the illustration so as to reinforce the under side of the intersecting slabs between the column supports and to reinforce the upper face of these

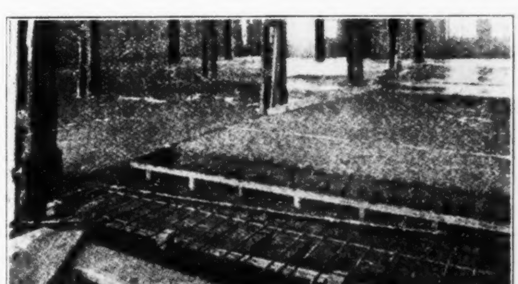


Fig. 4.

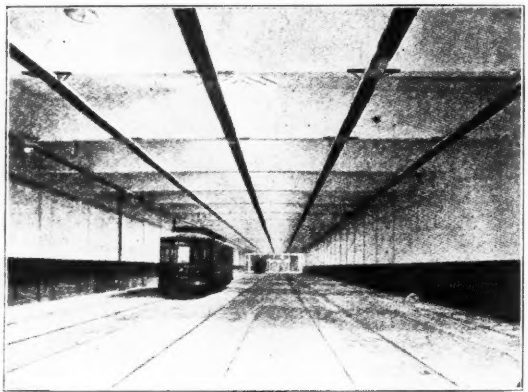


Fig. 5.

slabs over the column supports and for a considerable distance each side of the column in order to provide for tension due to negative moment in this region. In addition to the longitudinal reinforcement, the intersecting slabs are reinforced laterally near their upper faces by ½-in. round bars which extend across the full width of the intersecting slabs and a considerable distance into the enclosed slab. This lateral reinforcement serves a double purpose:

(1) Reinforcing the intersecting slabs against bending laterally and hence the loads from the enclosed slabs are distributed over and carried by the full width of the intersecting slabs instead of being carried by their adjacent edges only; and

(2) Taking care of the tension in the upper face of the enclosed slab due to negative moment, thus restraining these enclosed slabs and reducing the positive moment in them.

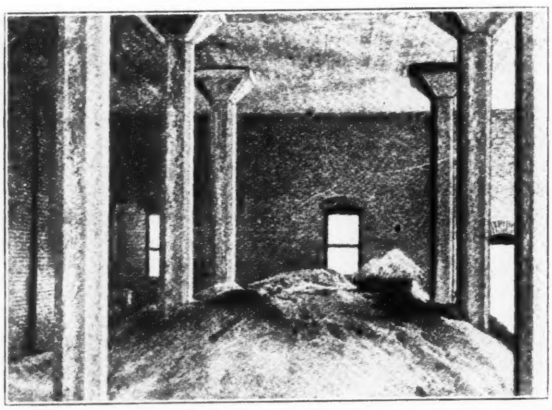


Fig. 6.

The lower reinforcing of the enclosed slabs consists of two layers of ½-in. round bars placed at right angles to each other (spaced closer together in the middle portion), near the under face of the slab to reinforce it fully for tension due to positive moment. These slabs are also reinforced around their sides, near their upper faces by the ½-in. bars already referred to, for tension from negative moment.

An important feature of this design is the combination of the column heads with the intersecting slabs, whereby the depth and hence the strength of these slabs is greatly increased in the region of greatest negative moment, namely at the supports. Between the column heads the intersecting slabs have their upper faces supplemented by the concrete in the enclosed slabs and, therefore, they may be considered as having a wide T section, thus increasing the strength of the slab to resist the compression due to positive moment between the column heads. The wide column heads, of course, reduce the clear spans of the intersecting slabs. By paneling the ceiling in its middle portion, a great saving is made in material and hence in the dead weight, over what would be necessary if the entire slab were of uniform thickness.

This construction is so designed that wherever possible it is made continuous over supports, hence the deflections and stresses are much less than is the case for non-continuous construction. It is this feature, which can be secured so easily in reinforced concrete construction, that makes it possible greatly to reduce the depth of beams and slabs where they are properly reinforced.

As will be seen by referring to the floor plan, Fig. 16, it is possible in this construction to provide openings anywhere in the enclosed slabs or to omit the enclosed slabs altogether without thereby weakening the construction in any way; or any one of the intersecting slabs may be changed in

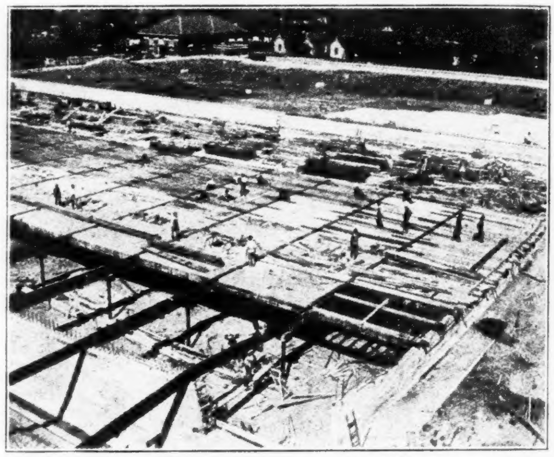


Fig. 7.

position, thus readily providing openings for elevator and stair wells, and still leave the stresses in the construction determinate.

In the girder and beam design shown on the right of Fig. 15 and in Fig. 20, a 4-in. slab is supported by beams spaced 8 ft. apart, which in turn are supported by girders connecting to the columns as shown. The girders are 23 in. wide by 26 in. deep under the slab, or 30 in. over all, and the beams are 11½ in. wide by 22 in. deep under the slab, thus making the maximum depth of the floor for the typical panel

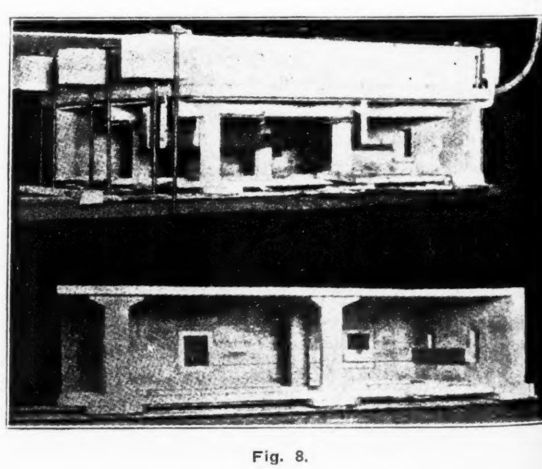


Fig. 8.

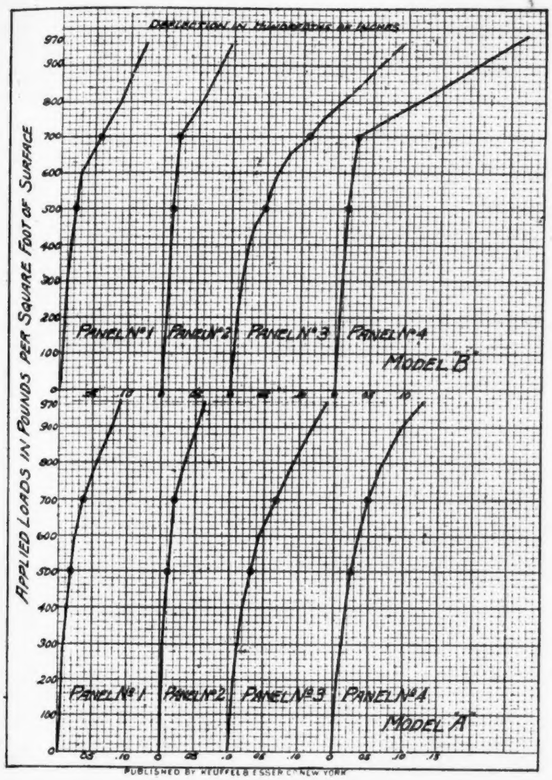


Fig. 9.

30 in. The maximum depth of the floor of the typical panel of the adopted design is but 12 in., as shown in Fig. 15 and Fig. 19.

Both of these designs were calculated for a live load of 100 lbs. per sq. ft. and for the bending moments for beams and slabs and the unit working stresses for concrete and steel allowed in the proposed revised Chicago City Building Ordinance. That is, the moments for beams and slabs were calculated as $WL^2/12$ for intermediate spans, as $WL^2/10$ for end spans; the maximum allowable compression in concrete in bending was taken at 700 lbs. per sq. in. and the maximum tension in the steel at one-third of the elastic limit or 18,000 lbs. per sq. in. The maximum shear or diagonal tension in concrete without reinforcement was taken at 40 lbs. per sq. in.

The quantities of concrete and steel in these two designs, taking into account the extra concrete in the column heads in the adopted design, are nearly the same; in fact, there is 6 per cent less concrete and 3 per cent more steel in the girder and beam design than in the adopted design. With the prevail-

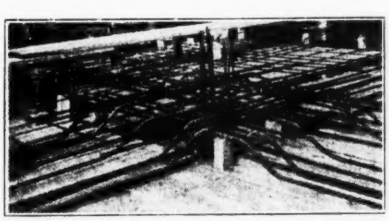


Fig. 10.

ing unit prices for concrete and steel the total cost of materials alone is practically the same for the adopted design and the girder and beam design. But in the cost of the formwork and of placing the steel and concrete in the two designs, there is a great saving in favor of the adopted design. The greater simplicity of the formwork required for the adopted design over the girder, beam, and slab design can be seen by comparison in Fig. 19 and Fig. 20.

The columns in the Studebaker building are of the Gray type and are built up of eight steel angles and plates, riveted together as shown in Fig. 21, and surrounded by concrete. The steel is designed to carry the full load in the lower stories, without taking into account the concrete. According to the requirements of the building ordinance referred to, structural steel columns with milled and spliced joints, when embedded in and surrounded by concrete, may be designed on the basis of allowing a stress per sq. in. in the steel of 18,000—70L/R, but never to exceed 16,000 lbs. per sq. in. If the concrete is assumed to carry part of the load, then the stress in the steel is not to exceed 15 times the stress in the concrete. Without hooping the columns, the stress in the concrete is not to exceed 500 lbs. per sq. in., and the steel 7,500 lbs. per sq. in. The basement columns carry nearly 1,000,000 lbs. each and have approximately 60 sq. in. of steel. The seventh story columns are designed as reinforced concrete columns. In these columns steel tees replace the

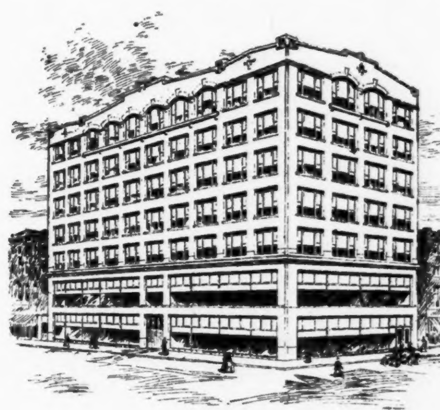


Fig. 11.

angles. The fifth and sixth story columns are shown being erected in Fig. 22. This particular type of column is not essential to this construction.

The reduction in the height of buildings gained by adopting a floor and ceiling construction of this type, without beams or girders, results in effecting a saving in walls and columns; in equipment for elevator, heating, plumbing, sprinkler systems, and lighting; and in the annual expenditure for elevator operation and for heating. By the elimination of deep girders and beams, the lighting of the rooms is greatly improved and, therefore, there is a saving in the cost of illumination. These benefits are also obtained by other forms of flat ceiling construction, but two marked advantages of this construction over other designs are:

(1) That the stresses due to the weight of the structure itself, as well as loads to be carried, are determinate and therefore designs for this construction can be made with the same assurance as to their strength that is demanded for designs of railroad bridges and similar structures.

(2) By paneling the ceiling and thus making the slab thinner in the middle, the amount of concrete and consequently the weight of the structure to be carried by the columns is greatly reduced. In the case of the Studebaker building, the reduction in the dead weight amounts to over 3,500,000 lbs.

These several advantages are gained without sacrificing architectural appearance, for the architectural effect of this construction is pleasing, presenting a happy combination of the lines of strength and beauty.

Appendix.

Of the "seven types of reinforced concrete construction" outlined at the beginning of this paper, the first five are each illustrated by the following examples selected from structures designed in the writer's office.

The first of the seven types of reinforced concrete construction referred to, that is, "slabs on steel joists and beams," is illustrated by the floor construction designed for the Heath & Milligan Mfg. Co.'s building, and is shown in Fig. 1.

The second type "reinforced concrete slabs and beams carried by steel girders," is illustrated by the construction of the reinforced concrete roofs over filter beds, designed for the Indianapolis Water Co. and shown in Fig. 2, Fig. 23, Fig. 24 and Fig. 25. Here steel girders were used so that the forms for the concrete might be suspended from the girders instead of being supported underneath. In passing, it may be of interest to mention that the steel girders are each 200 ft. long, resting upon eleven supports spaced 20 ft. apart, being 18-in. I-beams spliced with 15-in. channels. These I-beams were furnished in long lengths and spliced at the quarter points of the span instead of at the columns, as shown in Fig. 23, as it was important that they act as continuous girders. The reinforced concrete joists or beams were each 350 ft. long and also continuous over 19 supports, the spans being a little less than 20 ft. each. They were reinforced for tension over the supports as well as for tension between the supports, as clearly shown in Fig. 24. Likewise, the roof slab, which was but 3 in. thick, was reinforced for tension over its supports as well as between the supports, by bending the reinforcing rods as shown in Fig. 24. Each of these roofs was 200 ft. wide by 350 ft. long, covering approximately 1 2/3 acres. No expansion joints were provided in these surfaces nor was any waterproofing used. Gravel concrete of a 1:2:4 mix was used. Each roof drains toward one end and is covered with 2 ft. of cinders. After a heavy storm water runs through the drains for two or three days, nevertheless the roofs do not leak. The cost was much less than that of many other reinforced concrete

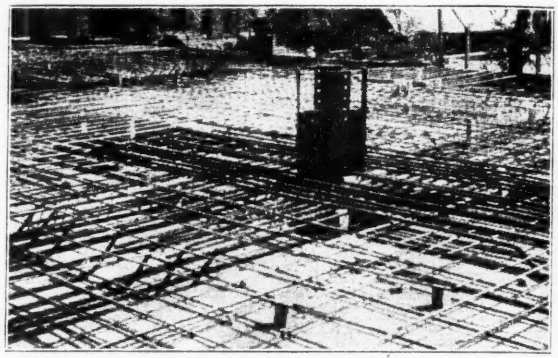


Fig. 17.

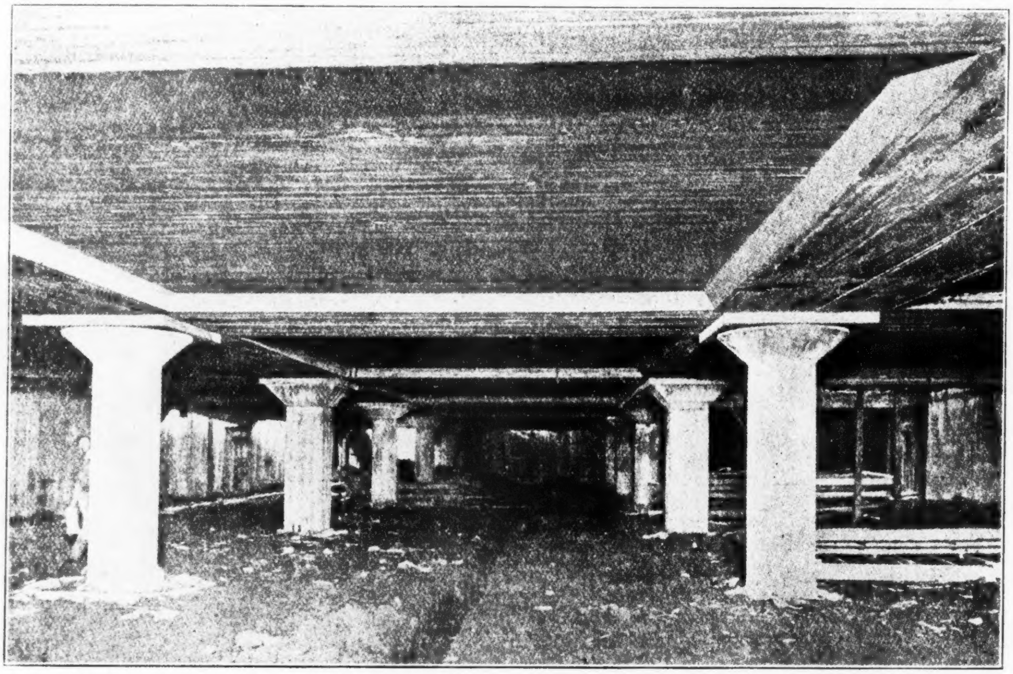


Fig. 13.

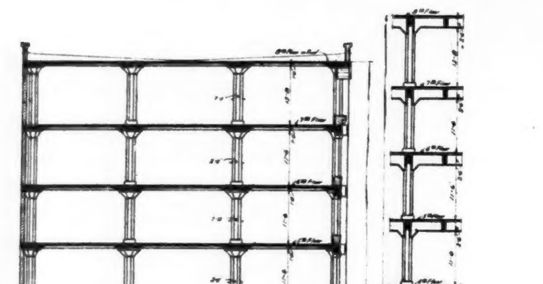


Fig. 15.

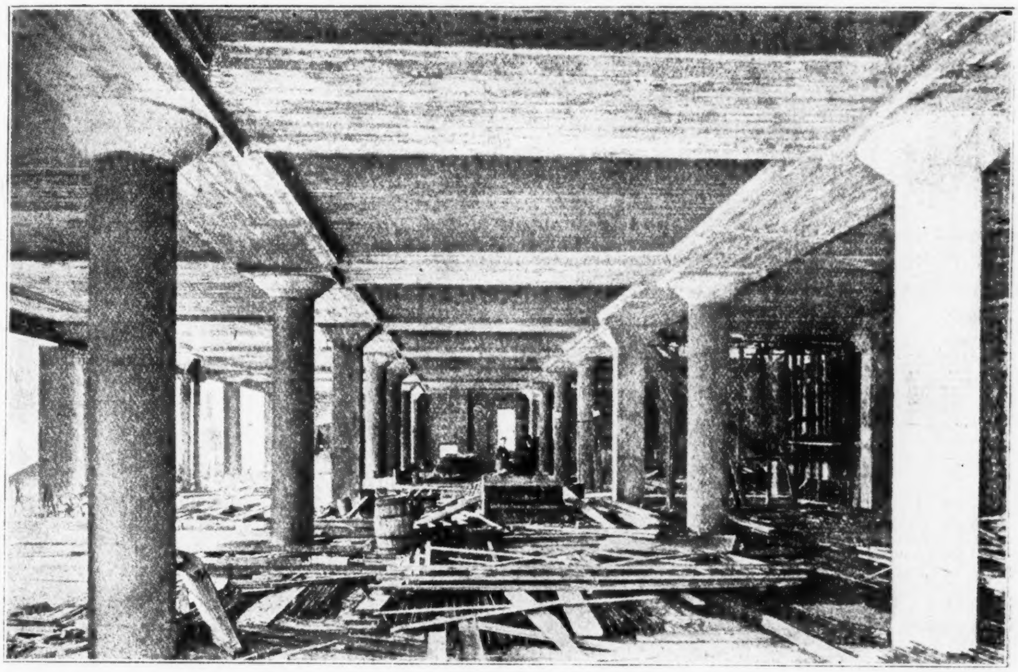
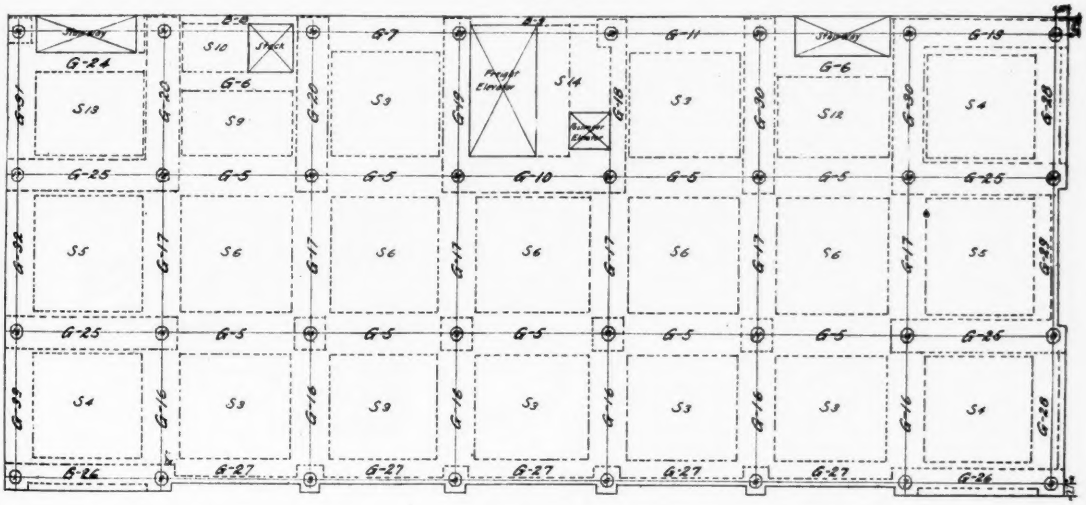


Fig. 14.



TYPICAL FLOOR FRAMING PLAN

Fig. 16.

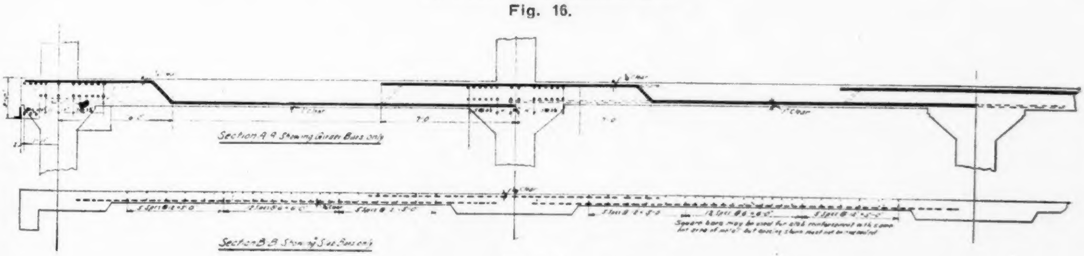


Fig. 17A.

roofs designed for similar purposes, being under 40 cents per sq. ft. of roof surface, including the steel girders and iron columns supporting the same.

The third type, namely, "long span slabs supported on steel girders," is illustrated by the reinforced concrete construction of roofs designed for the Chicago City Railway Co., one of which is shown in Fig. 3, Fig. 26 and Fig. 27. In this case the roof consists of a reinforced concrete slab $4\frac{1}{2}$ in. thick spanning 16 ft. between supports, these supports being riveted steel trusses having a span of 56 ft. between walls. Later two more roofs were built with reinforced concrete girders substituted in place of the steel trusses. No waterproof covering or waterproofing compound was used, but the reinforcement is so placed as to take care of all tension stresses due to loads and to temperature changes, hence no cracks have developed which let

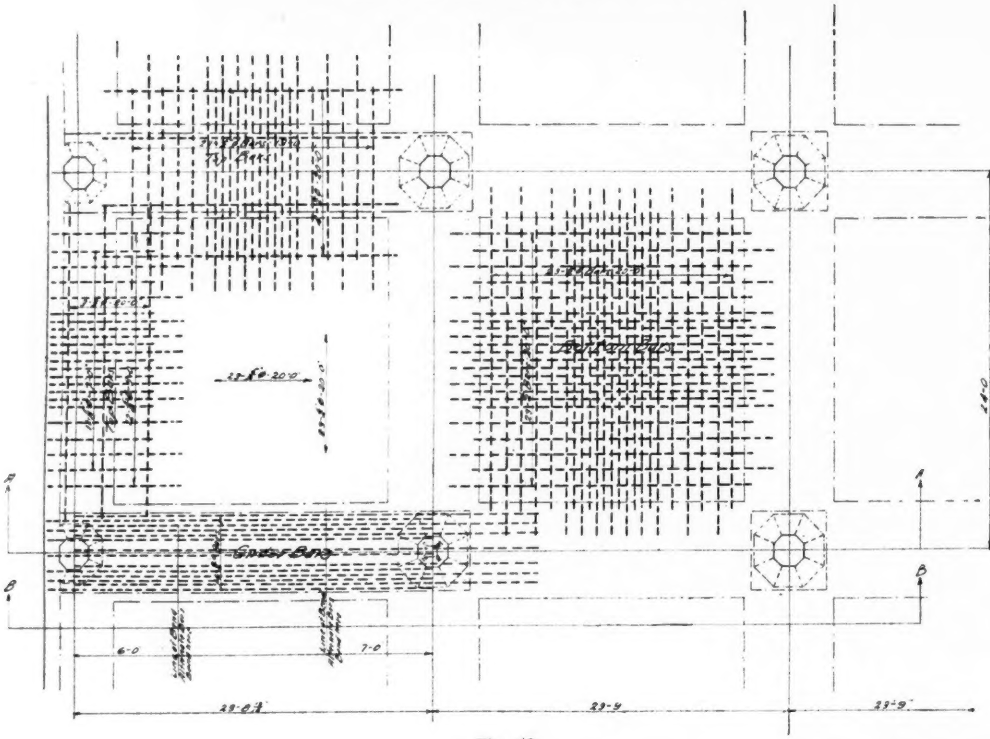


Fig. 18.

water through. Over 20 acres of these roofs are now in service and giving excellent results. The roof shown is over 500 ft. long and nearly 400 ft. wide, covering over 4 acres, and is built without expansion joints in its surface. This is also true of the other three. Our success with the Indianapolis roofs led us to design the first two of these roofs for the Chicago City Railway Co. In the two later roofs some modifications were made in the arrangement of the reinforcing bars, especially in that some of the bars in the upper face were made to run the entire length of the panels instead of extending only a quarter of the panel length each side of the supports.

Where the length of a span is so great that a slab of sufficient strength to carry the load becomes too heavy, it has usually been found better to use subdivided panels, with reinforced concrete beams and girders as well as slabs. This is the "fourth type" referred to and is illustrated in the reinforced concrete construction designed for the Advanced

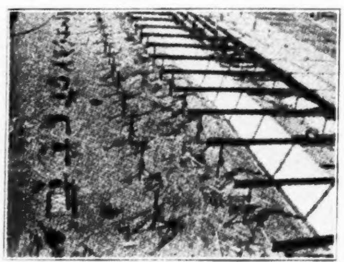


Fig. 23.

Thresher Co.'s building at Kansas City, Mo., shown in Fig. 4 and Fig. 28. In this building the girders have a span of 24 ft. between columns while the beams have a span of 18 ft. between girders and the floor slab a span of 8 ft. between beams. The floor slab is 4 in. thick, the beams are

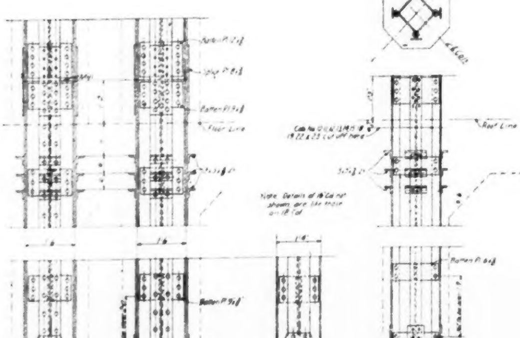


Fig. 21.

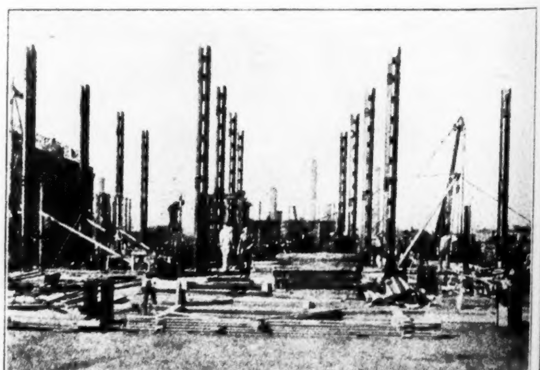


Fig. 22.

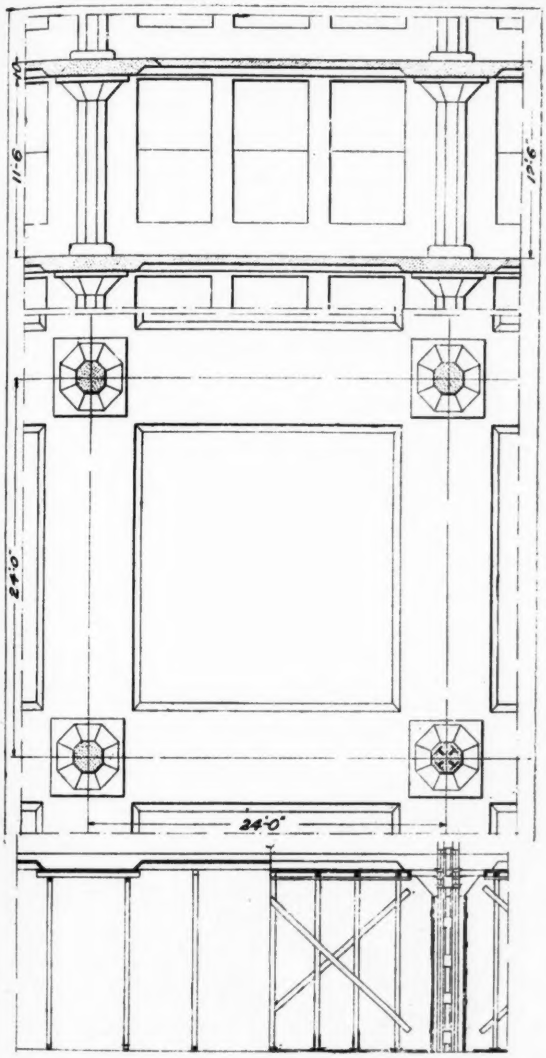


Fig. 19.

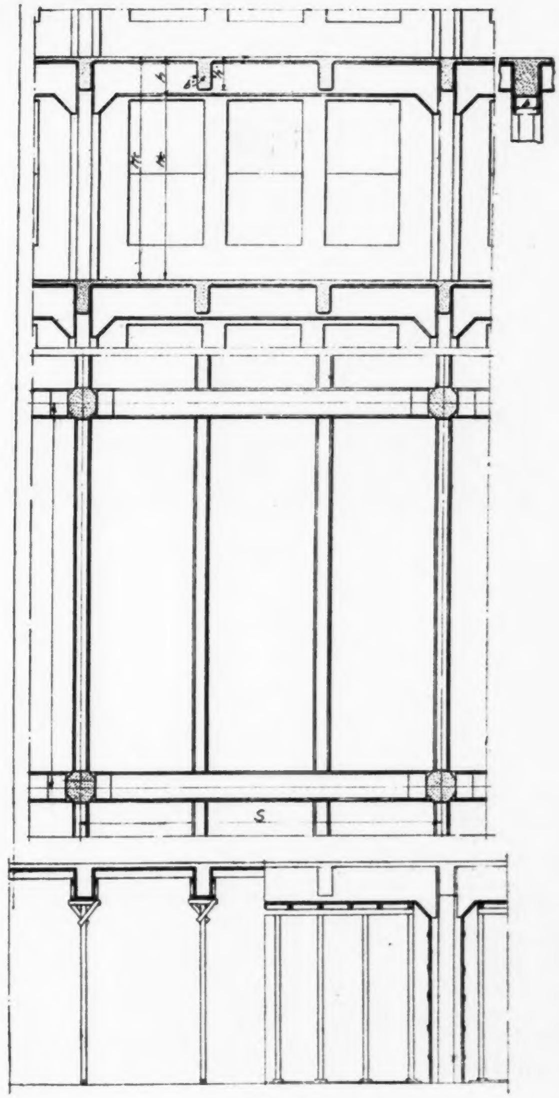


Fig. 20.

21 in. deep below the slab and the girders 27 in. deep below the slab, therefore the total depth of the floor is 2 ft. 7 in. These floors were designed for a live load of 250 lbs. per sq. ft. and are subjected to heavy concentrated loads from traction engines carried in stock.

A typical example of the "fifth type" of reinforced concrete building construction, in which the floor consists of slabs, supported by girders running in one direction only, is illustrated in the reinforced concrete construction designed for the eight story Manufacturers' Furniture Exchange building in this city, shown in Fig. 5, Fig. 29 and Fig. 30. In this building the slabs have a span of 14 ft. between girders and the girders have a span of approximately 18 ft. between the calumns. The construction is clearly indicated by the drawing, the slabs exclusive of the top finish being 5½ in. thick for the first floor and 4½ in. thick for the remaining floors. The girders being 1 ft. 5 in. deep for the first floor and 1 ft. 1 in. deep for the remaining floors, measured under the slabs, making the total thickness of these floors, including the top finish, 1 ft. 11¼ in. for the first goor and 1 ft. 6¼ in. for the other floors. The columns in this building were of concrete, reinforced with four angles latticed and

Fig. 24.

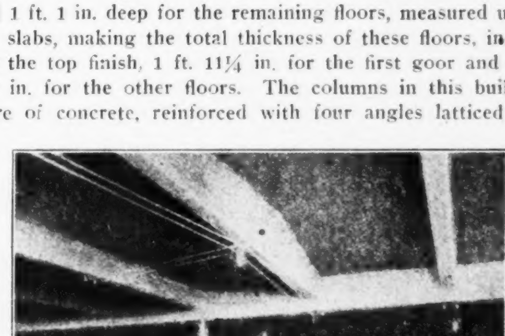


Fig. 25.

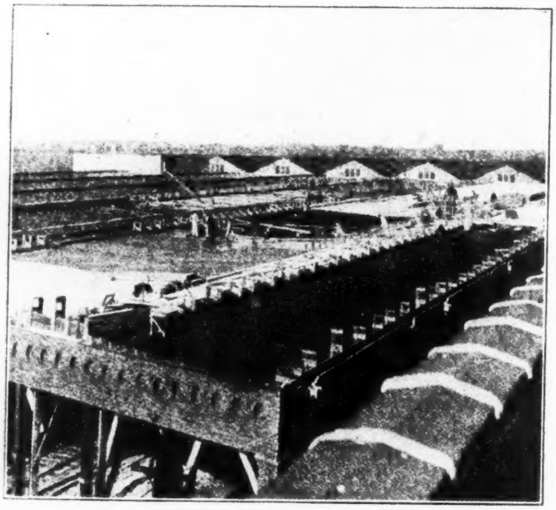


Fig. 26.

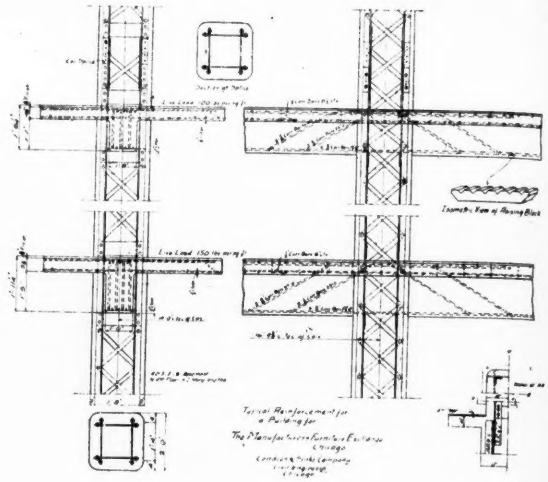


Fig. 29.

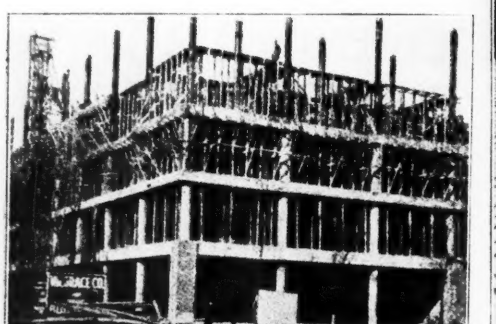


Fig. 12.

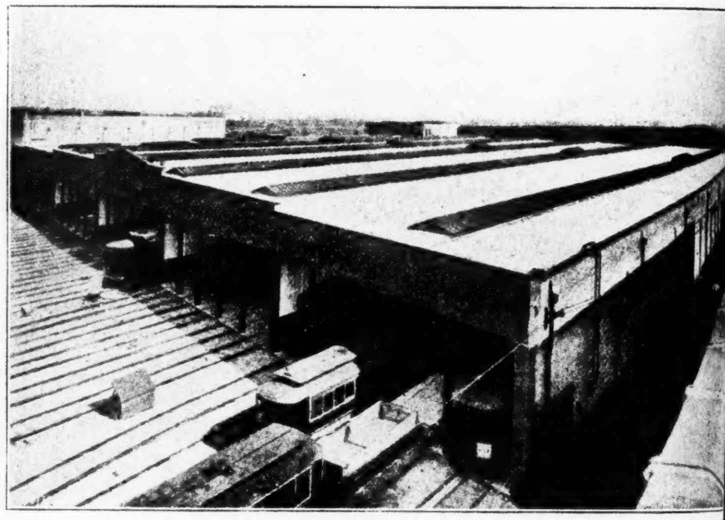


Fig. 27.

Fig. 30.

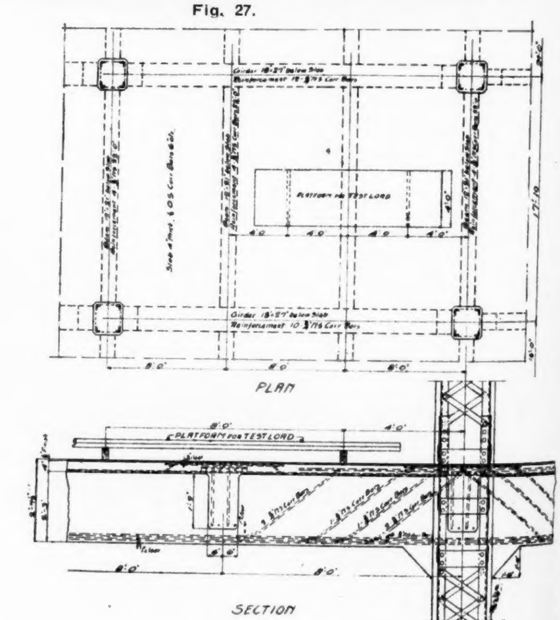


Fig. 28.

were riveted together at their splices, permitting several stories of formwork to be carried on the columns ahead of the floor construction.

Seasoning and Preservative Treatment of Ties

(Continued)

DISCUSSION.

Mr. Lamb (Consulting Engineer): In the United States alone, during 1907, 153,699,620 ties were bought by the steam and electric railroads, and in the panic year of 1908, 112,463,449 ties were bought. That one year's supply cost at location of purchase $56,280.568. Therefore, the subject is one involving great interests and is worthy of your most serious consideration.

As our forests become depleted, we find the price of untreated ties increasing and the difference in the saving of cost by using the preserved ties steadily increasing. Our government, however, has at last awakened to the seriousness of the situation, and both state and federal governments are studying means of conserving our forests.

After years of experience in practical forestry work, I am convinced that many of the theoretical recommendations for handling of our present forests are impractical, such as cutting only trees of a mature growth and large size, and leaving the remainder for future use. A lumberman in the East seldom expects to find more than about 5,000 ft. board measure to the acre of total area. It does not pay to log an area of much less than 5,000 ft. B. M. to the acre. Therefore to take only the larger logs would in most cases reduce the available timber to an extent that would make it unprofitable to operate the tract. Moreover, in felling the large trees, many of the smaller ones are destroyed. Slight trimming or cutting of the trees in a forest assists the growth of the remaining trees, but much cutting of the larger trees makes a change in the conditions surrounding the younger ones, that often causes them to die. In Europe, where trees have been planted, the cutting of trees about the same age can be carried on systematically. Where the old forests have trees of all ages a more difficult problem presents itself. It is often necessary to use the smaller trees, and this is the class of timber from which we get most of our ties. The conservation of our forest resources can best be carried on by treating or preserving the wood after it is cut, so that a less quantity will be needed to meet our requirements.

Substitution of other materials for wood has taken place of late years to a great extent. Steel and reinforced concrete are used in many places where wood has been used heretofore, and these materials have been tried for ties. But where resistance is required, as is the case of ties, it is hard to find a substitute for wood. It is, therefore, important to conserve the wood supply for ties in every possible manner.

The Pennsylvania has set a good example of the first best step to that end, in planting trees for future use for making ties. All large trunk lines should follow this example. But this is a slow method, and for immediate requirements we must take into account the remaining available timber, seeking to extend its service to the furthest date possible.

In the United States, the common indigenous woods suitable for ties and their respective average lives, depending largely upon their locations are: (1) white oak, 7 to 12 years; other oaks, 4 to 9 years; (2) chestnut, 5 to 10 years; (3) long leaf pine, 5 to 8 years; (4) cedar, 6 to 12 years; (5) cypress, 8 to 9 years; (6) short leaf pine, 4 to 6 years; (7) hemlock, 5 to 7 years; (8) tamarack, 4 to 7 years; (9) fir, 4 to 7 years; (10) redwood, 5 to 12 years.

There is a large quantity of short leaf pine suitable for ties still remaining. This wood when treated will last as long as the naturally more durable woods when similarly treated. I have noticed a tendency on the part of engineers to specify for ties to be creosoted "long leaf heart pine," as though they lacked faith in the preservative and wished to fall back upon what extra life it might have by its being heart pine. There is nothing in this, for experience has shown that a wood that will admit of thorough impregnation of the preservative lasts longer than the heart wood, which resists treatment. I do not understand the value of the heart wood for untreated ties. When I was chief engineer of the Wilmington, Newbern & Norfolk in 1888, I saw a tie that was at that time in use in a neighboring road, the Atlantic & North Carolina, that was a sawn tie of tapped, long leaf pine. Practically all of the tie was what we call "light wood." It was thoroughly impregnated with rosin. It had been in that railroad in constant service for 30 years and was still in good condition. It would be exceedingly difficult now to get such a tie. This example was an exception to one of the general rule for tie cutting, for we all admit that a hewn tie, whose surface pores are somewhat closed by the planing effect of an adz is more durable than a sawn tie whose surface pores are opened by a ragged cutting of a circular saw. It shows that when a tie is impregnated with a preservative, we can disregard its being sawn.

A few years ago, it was common for engineers to specify that no bled pine should be delivered. My experience is that the butt logs are improved in strength and durability, by bleeding for rosin. The tie referred to was from a tree bled for rosin, as the scar showed.

Another wood that can be gotten in large quantities is tupelo or black gum. This wood is now practically shunned. It has many bad qualities. The negroes call it "de mule wood," because it is so perverse. You can't split it; when sawn it warps excessively and twists to a remarkable extent. It is never used as fuel, nor for paper pulp. It will not float when cut with sap in it. The negroes claim that the wood is so mean that even the lightning won't come in contact with it. It is said that you seldom, if ever, see a lightning-struck tupelo tree. In spite of its bad name, I venture to predict that at no very distant date the railroads of the United States will seek this wood for ties. The trouble does not lie in the wood itself, but the conditions surrounding it and the method of it streatment. As the darkie said:

> "Eb'ry one say dat de mule is bad
> When he plunge an' kick an' rear,
> Nobody know dat de mule is mad
> Cause de gadfly bite his ear."

Though this wood seems exceedingly bad, if handled in the right way it becomes an excellent lumber.

I have made thousands of curtain poles 1½" x 1½" x 5' long of tupelo and they did not warp or twist, and the wood was excellent, close grained, taking a high polish and had few internal defects, such as large knots, gum spots, wind shakes, etc., common to many other woods. I have made rollers of tupelo that would stand abrasion better than any other wood I know of. When I was chief engineer of the Brooklyn Dock and Terminal company, I built a coal handling plant with a vamp, up which heavy coal cars are handled by a steel cable passing over seven foot diameter sheaves at the top and bottom of the further end of the coal pockets. The locomotive is attached to one end of the cable and the car to the other. When the locomotive goes away from the vamp the car is pulled up. The angle of the vamp with reference to the horizontal top of the coal bins is 49 degrees. A switch is placed on the vamp near the top. This causes the cable to be deflected at the top, causing the cable to chafe at the angle, so that it cut through iron and oak rollers. I finally put there a chafing log of oak and kept it greased. This soon wore out. Later I put tupelo in the place of the oak, and its life was many times that of oak and proved satisfactory. This would indicate that the base of the rail or tie plate would not wear as much into a tupelo as into a white oak tie.

My secret for preparing tupelo is to girdle the trees during December, when the sap has gone out to its maximum extent, then to leave the trees standing until the following December, when they are felled. It will then be found that they can be cut without fear of the lumber warping or twisting. The sap

being out they will float. The pores of the wood are in good condition to take creosote, and, while the wood compared with other woods is short lived, when creosoted it will be found to be of equal duration. In using the wood for ties its resistance to abrasion will be much in its favor, and its resistance to the withdrawal of spikes, and its non-splitting qualities, which will tend to hold the spike in ties on curves, will still further add to its value as a wood for ties. The fact that it has not been used to any extent heretofore makes it more plentiful than many other woods in locations where timber has been extensively cut.

I have reported the number of ties bought during 1907 and 1908, showing that many more were dealt in during the former year than the latter. In spite of this fact during 1907, 15,124 of those ties were gum, while 261,155 of gum were among the lesser quantity bought during 1908. I predict that there will be a steady increase in the use of gum for ties each year, now that they have begun to treat it with a preservative.

I take exception to Mr. Angier's conclusion that it is best to season ties before they are treated for preservation. We can disregard the established fact that seasoning timber will lengthen to a moderate extent the life of wood, as we propose to treat the wood with a preservative that will give it a life far in excess of that gained by mere seasoning.

Every one familiar with kiln drying lumber knows that partially air seasoned lumber, especially hard wood, checks and splits more than that which is treated green, when dried in a kiln. This is due to the fact that air drying is mostly on the surface, and the moisture in the center of the wood when subjected to heat expands and splits the wood. When green, the moisture on the surface being heated first, gives a chance for that on the inside to heat slowly. Of course, it takes longer, but too much advantage is gained in not having the damaging cracks for moisture to penetrate to justify the attempt to save the small amount of extra time in the kiln drying. What is experienced in kiln drying is also experienced in the cylinder treatment of wood, before injecting the preservative. It is common to hear an explosion, and find ties split in two, in treating partially dry ties in a creosoting cylinder.

When wood is properly treated or seasoned in the cylinder process, it can be removed showing freedom from checks or similar defects which are common to air dried lumber. Air drying closes the pores on the surface. Steam drying quickly penetrates all the pores, and with the vacuum draws out all the deleterious sap.

It is worth your notice that a tie that is air dried, weighed and treated in a cylinder injecting a given number of pounds of preservative per cubic foot will show a greater gain in the total weight than a tie that is green, weighed and treated with a given number of pounds of preservative per cubic foot. This is due to the fact that in the first case, much of the sap having been removed, the tie will weigh less per cubic foot than the green tie, to start with, and it will absorb moisture from the steam. When the sap is taken from the green tie, its loss in weight per cubic foot will be much greater than that of the air dried tie, and the addition of the same weight of preservative, in both cases, will still show a greater loss in weight per cubic foot of green as compared with that of the air dried tie. Three facts must be taken into account if you attempt to determine by the ultimate weight per tie whether the proper amount of preservative has been injected. The above facts also show that you can get rid of more of the cause of decay, the albuminous sap, by treating a green tie than by treating one that is air dried.

I also take exception to Mr. Angier's conclusions in regard to the difference in cost, in treating seasoned and unseasoned ties. In his calculations he has left out of account interest on cost of the extensive grounds and other facilities such as tracks, etc., needed to store the 900,000 ties held in reserve while drying. At least, until 900,000 ties are in stock the railroad would have only one way freight, while if handled green the same train would take away treated ties. If the railroads own the plant this would be quite a consideration.

Mr. Angier's calculations would be upset if you simply figured on putting in extra cylinders to allow for the extra time necessary in treating green ties over those that are dried, when the difference in the extra cost of air drying over cylinder drying would throw the gain in favor of cylinder drying. The common practice of large timber mills in kiln drying, instead of air drying their timber is a proof of the fact that it is cheaper to kiln dry than to air dry.

I note that Mr. Angier says that he uses only one hour in producing 21 inches of vacuum. I therefore presume that the 21 inches is simply reached. It is customary to take an hour to pump a 24-inch vacuum, and to hold it until all sap is withdrawn from the wood. I do not think one hour is sufficient time for supplying the vacuum.

I also take exception to the statement that "ties will season more rapidly in warm weather than in cold weather." Cold, dry air, (not freezing), will season lumber as quickly as when hot. In fact, hot weather often keeps the lumber damp. It is the air passing over the lumber, whether hot or dry, that seasons it. You cannot season lumber by baking it. You must pass the hot or cold air over the surface of the wood. There are excellent kilns using air artificially cooled.

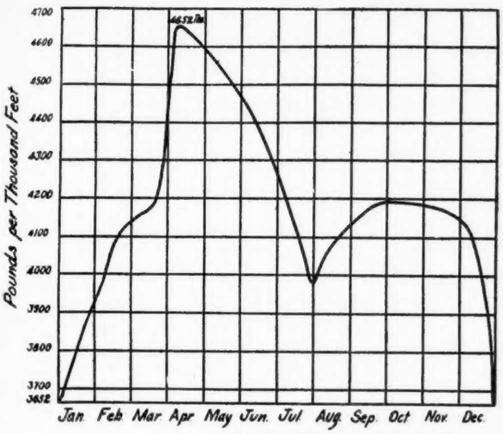
I do not under-rate the advantage of having as much as possible of the sap out of the tree before treating, as long as the tie is in a natural condition in regard to moisture. We all know that ties cut when the sap is out of the tree last longer than when cut with the sap in. Such ties can be more rapidly and as successfully treated as the ties cut from timber with the sap in, and more successfully than those that have been air dried.

It is contended that cutting timber when the sap is down limits the time of tree felling to too short a period. I found that with short leaf pine, the sap goes down in the trees twice a year. I was cutting short leaf pine timbers in Virginia and shipping it to New York is fast as cut for use as flooring beams in buildings. Every year during the last part of March and the first part of April, I could make no money in the business, and during October, I could only make about half as much as during the last part of December and the first part of January. I examined all scales on which the lumber was weighed, took note of whether the timber was cut uniform size, but could find no reason why the weight increased so that the extra cost of freight due to extra weight equalled, during April, all of my profits, and during July about half of my profits. I finally made a graphical analysis of the variation in the weight of the shipments of timber, extending over several years, and plotted the average weight per cubic foot B. M. for each month, and learned thereby that the sap rises and falls with great regularity twice a year, only varying with the lagging of spring. The diagram is reproduced herewith.

In the case of short leaf pine the difference in weight of sap between the last of December and the first part of April in 1,000 feet B. M. is practically 1,000 pounds, out of a total gross weight of wood and sap of 4,652 pounds per cubic foot B. M.

By cutting ties the last of December up to the 10th of February and during the last week of July and first week of August, or girdling the trees at that time to be cut later, an extraction of 658 pounds of sap per foot B. M. can be secured. The better plan would be to send in to the forest a large force of men to girdle the trees the last week in December and first week in January, when from 900 to 1,000 pounds of sap per M. foot B. M. would be avoided. The common belief that it is best for the timber that is to be cut when the sap is at rest does not apply when the timber is to be treated. That theory is based on the belief that bacteria form mostly when the sap is in motion.

By the law of concomitant variations, we are forced to admit that sap is the medium of wood decay. The question then is,



NOTE. Figures show lbs. per M. ft. board measure, of green timber cut from same district in Virginia.

Diagram Showing the Flow of Sap in Pine (Pinus Mitis) Throughout One Year

what ingredients of sap are the direct or indirect cause of decomposition? I believe it is generally admitted that it is the albumen in the sap. However, as albumen is one of the constituents of the fiber of the wood, we will always have present in wood the matrix of decay. The mere oxidization of the albumen does not produce decay. Sap pine often in murky weather, when first cut, will at once turn black by oxidization, if the conditions are favorable. An axe cutting sap wood will turn the sap black by oxidization. I have seen sap pine timber in very old houses in Virginia still sound but having its sap stained black. Many people consider this discoloration as the first evidence of decay. This is not correct.

It requires alternating wetting and drying to cause the albumen to germinate the bacteria of decomposition. Wooden handled tools thrown into the Tiber at the time of Nero have of late been found in perfect preservation, as also piles driven under the water of that river. Timbers kept continually dry but not having their ends sealed, so as to cause dry rot, are to be found in cathedrals hundreds of years old. But the same timber, if placed like a tie on the ground where it can be alternately wet and dry, would soon decay.

It would seem, however, that to attempt to exclude all moisture from ties would be impractical, so we have to resort to treating the albumen so as to destroy its power to produce bacteria. The old theory that coagulating the albumen accomplished that result is no longer entertained. Albumen is coagulated by heat, as is evidenced by the cooking of an egg, but that condition does not prevent its decomposition. It has been found however, that poisons, disinfectants, prevent the germination of bacteria in albumen and hence the efficacy of such processes as Burnetizing or zinc-chloride process, kyanizing or bichloride of mercury process; Thilmay or sulphate of copper process and Bethel or creosote in hermetically sealed cylinder process. Also the many patented so-called improvements upon these processes.

The life of wood is not altogether dependent upon its porosity. Some persons believe that the resiniferous woods are the most durable. If so, how can we account for the exceeding long life of cedar, juniper and cypress, which are practically void of rosin, and very porous. Coffins have been exhumed near St. Augustine, Fla., made of cypress, that were buried over a century ago, that were perfectly sound. The brass fastenings on them had disintegrated. Cypress wood weighs six pounds per foot B. M. when green and when kiln dried only about two and one-half pounds per foot B. M. When exposed to the open air it soon absorbs moisture and resumes its original weight. It is thus kept continually wet, and hence it is preserved.

The juniper must have much tannic acid in its make-up, for the tannic acid in juniper berries discolors to a dark whiskey color the water in deep water ways in which the tree grows. This juniper water is preserved in its original purity so that after being kept for years it is equally as potable as when first secured. This tannic acid undoubtedly disinfects the albumen of the wood and thus preserves it. Cedar has an attribute that is germicidal. Cedar boxes are used to keep vermin, moths and insects from contents placed within them. This attribute undoubtedly disinfects the albumen and preserves the wood.

The difficulty about the use of zinc-chloride, bichloride of mercury and sulphate of copper is that those salts are washed out or are diluted, and soon lose their virtue. Creosote, however, is staple and remains in the wood.

It is my opinion that the hydroscopic phenomenon of creosote oil has much more to do with its preserving qualities than has been heretofore acknowledged. The fibre of the wood, being coated with this water repelling creosote oil, prevents the water from being absorbed by the fibrous matter of the wood, and the albumen in the fibre is thus protected against infection. If creosote is forced into porous wood to practical saturation by compressed air, or a force pump instead of with hot steam, and steam be put into the pipe coils in the cylinder afterwards, the hot air will expand the creosote and cause it to drain out in greater quantity than if a vacuum be applied as in the Lowry process. It has been common practice for years to extract the excess oil, pumped into the wood, by vacuum or drainage. I am convinced that as good results will be obtained if the wood is saturated and allowed to drain, as if the whole of the creosote had been allowed to remain in the wood.

In circular 98 of the U. S. Dept. of Agriculture is shown the analysis of the creosote found in a tie that had been in use as long as 30 years, having only 7.41 pounds of oil per cubic foot; one with a service of 23 years with only 5.17 pounds and one of 20 years having 5.93 pounds. Undoubtedly more creosote oil was originally injected into these ties, and the pores of the wood had been coated with oil that protected the fibre, and the creosote had disinfected the albumen that was exposed in the pores.

The National Lines of Mexico, using crude petroleum oil, and the Santa Fe, using Bakersfield, Cal., crude oil, have treated ties that after three years' use appear to be absolutely preserved. These tests are made by a complete saturation of the ties, in the belief that it will prevent moisture from entering. The idea that the oil filled ties would be inflammable, and that spikes would work loose has been proved erroneous.

I believe, however, that the long successful experience in the use of dead oil of coal tar is of too great a value to be abandoned for any experimental material; not discouraging, however, making tests with materials that may promise a more economical process for future use. We now import 38,640,000 gallons per year of creosote for wood preserving, only getting 17,360,000 gallons from home sources. If the coke ovens of this country did not waste their by-products, we would have a super-abundance of creosote oil, and it could be bought cheaper.

It is very important that the kind of dead oil of coal tar to be used should be studied. The government tests as presented in circular 98 U. S. Department of Agriculture, show analysis of extracted oils from 19 cross ties with an average service of 21.84 years, had 9.58 lbs. of creosote per cubic foot. The distillation of the extracted oil showed the following percentages for their respective degrees of heat: to 306°, 0.025%; 205° to 245°, 12.07%; 245 to 270°, 13.88%; 270° to 320°, 23.80%; 320° to 420°, 24.69%. Residue above 420°, 25.27%; solid napthaline from distillates 1.19%; solid anthracene oil from distillates, 23.47%; tar acids CM[3], 0.65.

This can be interpreted as meaning that the light tar acids

are not present, and that the distillates are principally napthalene, anthracene and phenanthrene. Repeated tests have shown that these attributes of dead oil of coal tar are the principal staple preservatives of wood, and at least a good percentage of napthalene and anthracene should be demanded in creosote oil to be used for preserving ties.

It is generally conceded that creosote oil is the best wood preservative yet discovered, but the question is, does it pay to use it for treating ties? Take as an example:

An untreated short leaf pine tie, life 5 years—

7"x8"x8' at $15 per M. ft. B. M.	56 cts.
Laying	15 cts.
5% int. for 5 yrs. compounded semi-annually	9 cts.
New tie furnished at end of 5 years	56 cts
Taking out old and putting in new tie	25 cts.
5% int. for 5 yrs. com. semi-annually on above amount	11 cts.
New tie furnished at end of 10 years	56 cts.
Taking out old tie, putting in new	25 cts.
5% int. for 5 yrs. com. semi-annually on above amount	33 cts.
Cost of untreated tie at end of 15 years	$2.86

Short leaf pine tie treated with 10 lbs. per cubic foot of creosote oil, life 15 years—

7"x8"x8' at $15 per M. ft. B. M.	56 cts.
Treating with 10 lbs. creosote oil per cu. ft.	45 cts.
Laying	15 cts.
5% int. for 15 years compounded semi-annually	24 cts.
Cost of treated tie at end of 15 years	$1.40

Untreated tie $2.86, treated tie $1.40, saving by treating ties $1.46 per tie. This estimate shows that treated ties pay for themselves at the end of 15 years. When preserved ties are used, there is a greater efficiency of the roadway and a lessening of labor in keeping up the grade of the track, by not taking out old ties and putting in new.

One of the potent factors in tie preservation is the tie plate. At this late date it is unnecessary to argue in favor of its use. It has proved its value, but now that more of the softer woods will be treated and used for ties, it is important to emphasize the special value of tie plates. If the ties are well treated with creosote, plates with ribs or lugs can be used. My preference is for a smooth plate, somewhat wider than the common plate, which, in some cases has not been much of an improvement over the base of the rail for protecting against wear of the tie. We must look to an improvement in the spikes for additional help.

The variety of screw spikes and screw dowels used abroad, and to a limited extent tried in this country, is a step in the right direction. They involve, however, troubles and complications that engineers wish to avoid. A recently patented twisted spike, that makes a half turn in being driven into the tie has considerable merit.

I would suggest that it might be found advantageous to use ragged spikes. If properly made they need not disturb seriously the fibre, especially if holes are bored for them of a diameter slightly smaller than the size of the spike. We are all familiar with the use of ragged bolts for wooden trestle and wharf construction. They have proved that they hold timbers tighter together than plain spikes.

It is fortunate that spikes are found to hold firmer in creosoted than in uncreosoted ties. The government tests of pulling strength of spikes show as follows:

Kind of Wood.	Average force required to pull spike. Screw Spike. Pounds.	Common Spike. Pounds.
Chestnut	9,418	2,980
Oak	11,240	4,342
Long Leaf Pine	10,558	2,296
White Oak	13,026	6,950
Short Leaf Pine	8,504	3,474

From this table it will be seen that a common spike holds faster in a short leaf than in a long leaf pine.

If spikes could be obtained that would hold the plate tight against the tie, the life of the tie would be greatly extended. If properly creosoted and the abrasion under the rail practically eliminated, there is no reason why we could not secure at least 20 years of service from our ties, in which case a far greater saving would be made in using creosoted over using untreated ties.

Mr. E. A. Sterling: It is perfectly clear that the railroads are now so far advanced in matters of wood preservation that Mr. Angier does not find it necessary to advance any propaganda as to whether or not we should treat ties, for we have all reached the conclusion that the chemical treatment of wooden ties is the essential thing. Five or ten years ago a paper of this kind would have dealt largely upon the question of the advisability of treatment, but with this settled Mr. Angier is able to discuss methods and results and the technical problems which arise at all plants.

In regard to the kinds and quality of wood used; I will speak of our own conditions. We have been using preferably, as all the other roads have, white oak, but as the local supply has become gradually exhausted we have been getting an increasing number of our ties from other parts of the country, principally from the South. This means that we have been unable to get enough white oak ties locally because most of them have been cut out, and we have had to use red oak, beech, birch, maple, black gum and other woods which would have short life from decay without treatment. You will be interested to know that the first treated black gum used by the Pennsylvania went into the New York and Long Island tunnel. With the acceptance of cheap woods for treating almost any kind of timber and probably a whole lot of things which you do not want will be offered. This brings up the question of what you can treat and what you cannot treat and also as to what woods will stand the mechanical wear after they are treated. The same is true of the chemicals which are advocated as preservatives, and the preparations offered which are *said* to be better than creosote or zinc chloride are legion, but luckily we now know enough about most of them to eliminate without experiment. This is not the time to discuss the quality and kinds of creosote, but I want to say that the European market will be able to supply our requirements for a great many years, if we keep on using creosote at the rate we are now doing, and that home production should be stimulated.

In my opinion, in all preservative processes only well seasoned timber should be used. We base that on experience both at home and abroad. Large timbers should be seasoned in the open air at least 12 months, but six months is all right usually for ties and lumber. We have no difficulty in getting complete penetration with creosote in a well seasoned red oak tie, but if the ties are green and have to be steamed we cannot get uniform penetration at the center. I happened to be at the plant yesterday when they gave a 13 hour treatment to green pine piles and the best penetration was about four inches while with seasoned piles of the same character of timber treated earlier in the year full penetration was secured.

In the matter of checking: we find that that can be controlled in great measure by the use of the S irons. The prevention of checking is not such a serious matter and I believe the system of piling, as illustrated by the author, is an excellent one and has a great deal to do with the prevention of checking. In these piles 8x1 in this way the ties touch only at corners so that they are fully exposed to the air and yet the ends are protected from the direct rays of the sun. This is a system of piling used almost universally in European tie yards.

In the matter of chlorides and creosote, I think little can be added to what is stated in the paper of the evening. The treatment of ties by the railroads is purely a matter of economy and the question of how we can reduce the cost of treatment is always with us. We use a certain amount of creosote and a certain

amount of chloride; the question is how can we cheapen the cost of treatment by better organization at the plants or by reducing the amount of preservative. I think we are all interested in processes which aim to withdraw surplus oil by one means or another. I merely want to make one statement in regard to the use of a final vacuum. We have treated ties and in a small experimental cylinder pulled a 26-inch vacuum in two minutes; but the most we could possibly get out is 13% by weight. We have experimented with a long-continued vacuum and find that it is not successful for the reason that you do not get the full benefit after the first expansion of the air which is confined in the wood. The vacuum merely reduces the pressure on the outside.

Just one word as to what makes wood decay: we hear a great deal about bacteria and albumen and all those other things, but we do not very often hear the subject discussed in a technical way. Wood decays only through the action of wood destroying fungi which are propagated by spores under the three essential conditions of warmth, moisture and air. The starch, sugar, albumen, etc., which are in the sap and are withdrawn by steaming do not constitute the sole food of the fungi, the fundamental wood tissues still forming a favorable medium for growth under the three conditions named. I do not think there is anything that will destroy fungi and other spores so well as the chloride treatment. It is practically the only treatment which eliminates them. These spores are microscopic. They have only to light on a piece of wood and the decay sets in almost immediately and the fungi develops and produces more spores and very rapidly affects the whole of the tie. Now, the mineral salts naturally keep out these spores; so I think it is very essential that these preservatives should be used in all cases.

Mr. E. F. Hartman, Carbolineum Wood Preserving Company, said: When Mr. Curtis presented his paper to this club six years ago he stated that up to 1890, 269 patents had been granted in the United States on methods or materials for the preservation of timber. Last year the records of the Patent Office showed that the number had grown to more than 400 and the end is not yet. Bearing in mind that nearly all the successful methods and materials have originated with foreign inventors, we are forced to the conclusion that the American inventors paid but little heed to past experience.

Mr. Curtis traced the history of the wood preserving industry from the time that Noah was commanded to pitch the ark within and without, hence I shall limit my remarks to the progress made since the presentation of his paper in 1904. Air seasoned timber was specified in the patent granted to Bethel in 1838. The steaming of timber was introduced in 1846 by Pain but was discarded by almost all European wood preserving plants several decades ago. Six years ago the use of air-seasoned timber at treating plants in this country was almost unknown,—Mr. Angier to-night has forcibly demonstrated the economy and advantage of treating air-seasoned timber, and his road has tested various processes which gave promise of a better treatment. The use of air-seasoned timber is fast becoming the rule rather than the exception, so that we may safely say that there has been material progress in the last six years in this department.

Specifications for ties are becoming more exacting, not so much because of advancing prices, but rather because it is realized that the life of the tie is proportionate to the care exercised in excluding all possible defects. The method suggested by Dr. Von Shrenk of classifying Southern pines not according to their botanical names but according to the number of rings per inch is one that to me seems very much preferable. It takes an expert to distinguish a good grade of short leaf from poor yellow pine, and few roads can employ such men as timber inspectors.

No new material has been discovered, but Bakersfield oil and Beaumont crude oil are at present receiving some consideration. In view of the fact that these materials have no toxic qualities, it would seem probable, in the light of past experience with petroleum products, that their use can only become satisfactory when combined with some other material possessing this quality. Mr. Octave Chanute, the dean of the wood preserving corps in the United States, has carefully investigated materials of this nature both here and abroad and reported adversely. Combination treatments with materials already known have come more widely into use; but these might more properly be classified with new processes.

The adoption by the A. Ry. E. & M. of W. association of specifications for zinc chloride and distillates of coal tar and further specifications prescribing the method of analysis is a step in the right direction. The specifications for oil are, to my mind, insufficient inasmuch as they do not take into consideration the difference in the requirements for timber in the ground, exposed to the air, and timber exposed in water to the attack of boring animals.

Before mentioning any of the later processes, it might be well to refer again to Mr. Curtis' paper and the discussion on it. He as well as several others inclined to the belief that the Hassellman process, which had been brought out a few years previous, would prove successful, their opinion being based on its theoretical features, and in no case on a small test. Mr. Calvert, chief engineer of the C. B. & Q. reported that on his road this process had proved a dead failure. A reference to the latest report issued by Mr. Faulkner, of the A., T. & S. F., Nov. 16th, 1909, regarding the condition of the ties in the Texas experimental track, in which a total of 1,066 ties treated by the Hassellman or Barshall process had been laid, shows that this process gave only two and two-thirds per cent of efficiency on all ties treated. Thus, in the short time since the last paper on timber preservation was presented, one of the most promising processes has proved an absolute failure.

It might be of interest to note a summary prepared by me on the relative efficiency of the various processes tested in the Texas experimental track. The percentage of efficiency is for all woods treated. The first figures are based on the ties still in the track, this including not only those reported in good condition but also those reported split, unsound and showing decay. The second figures being percentage of efficiency for ties in good condition. Several other methods were tested, but in each case only a very limited number of ties of only one or two species were treated, and these have not been considered in the following table:

Process	Total ties treated	Percentage of all ties in track	Efficiency ties in good condition
Allardyce	499	94 %	55⅓%
Wellhouse	1000	73½%	46.7 %
Burnettizing	948	69⅕%	39½%
Zinc Creosote	514	19½⅕	14 %
Hassellman	1066	4⅗%	2⅔%

A study of the detailed report shows a marked difference in results on ties treated by the same process, but by different treating companies. This applies to two of the processes mentioned, the difference in one instance amounting to 56%.

Coming back to processes developed during the past six years, Mr. Angier refers to the Rueping and the Lowry processes; the latter being a modification of the Rueping process. Neither has been sufficiently tested to permit of forming final conclusions concerning their value. Both of these processes make use of a principle comparatively new in wood preserving, hence time alone will prove the value of either.

Capt. Oakes, of the U. S. army engineers, enumerates the following objections to the Rueping process: "It is argued that, inasmuch as the timber is not steamed, the hot oil dissolves and liquefies the natural substances of the wood,—i. e., resin, sap, etc.—and in drawing the air and oil out, when the vacuum pump is applied the excess oil is necessarily greatly adulterated, and its preservative qualities impoverished, and after this emulsion is used over and over a few times, while it may have the semblance of creosote, it is no longer a timber preservative. It will be seen that timber treated with an emul-

sion of creosote, sap, resin and water, with a great proportion of the preservative qualities of the creosote lost through evaporation and volatilization by reason of frequent reheating of the emulsion, will not endure much longer than timber in its green state."

In 1903, Mr. J. B. Card, whose father introduced the Wellhouse treatment in 1879, proposed a method of first injecting a small amount of tar oil, then immediately thereafter injecting a solution of zinc chloride, his object being to secure a better distribution of the oil throughout the wood than was possible with the ordinary injection of the same amount of oil, and at the same time protecting the interior of the timber with the zinc chloride. What is known as the zinc-creosote process, but perhaps more strictly speaking the "Ruetger process," which has been been successfully used in Germany for many years, is an injection of both zinc chloride mixed with tar oil at one time into the timber. This method, like the Rueping process, requires for its successful operation a very light grade of oil difficult to obtain and of high cost. To overcome the tendency of mixtures of oil and water to separate and to make the treatment more uniform, Mr. Card in 1906 patented a device mentioned in Mr. Angier's paper which represents the principle of the Card process. While it is too early to predict its ultimate value, the European results with a similar method would indicate that it is without doubt an improvement over straight Burnettizing.

By recalling the results in the Texas experimental track, you will note that the Allardyce process, which six years ago was but little known, gave the best results. In view of this, it is surprising that this process is only used to a very limited extent.

Six years ago two plants were operating in the United States employing the Kyanizing method. Only one of these remains in intermittent operation now.

Perhaps no process has called forth more discussion during the past six years than that known as the open tank process, which for simplicity of installation and operation is easily the cheapest. This process was developed in 1904 by Dr. Von Shrenk at the experimental plant operated at the World's Fair in St. Louis. It has been held by some that the Seely process of 1867 is identical with the open tank method of to-day, but nothing is further from the truth.

Mr. Angier can probably tell us of the record of his road which in 1868 laid some 25,000 ties treated by the Seely process. As these ties were treated under the personal supervision of Mr. Seely, it is only fair to assume that he did the work in the most thorough manner that the process would permit. Certain it is from the results that his theory of expanding and dissipating the moisture contained in the pores of the wood did not materialize. Mr. Curtis refers to it as a method of seasoning. As heretofore shown, the rule of to-day is to use air-seasoned timber, and as was said in a report to the American Society of Civil Engineers in 1885: "The Seely process consisted in immersing the wood in a closed iron tank of the oil and raising the temperature to between 212° and 300° F. This was supposed to drive all the moisture out of the wood, when the hot oil was suddenly replaced by a bath of cold oil, which, condensing the steam remaining in the sap cells, was supposed to rush in and saturate the timber thoroughly."

The open tank method of to-day is based on the principle of replacing expanded air with the preservative fluid, and should be used for air seasoned timber. The principle of the open tank process was laid down prior to the time that Seely patented his process and is in fact referred to in Britton's book on "Dry Rot in Timber." Its value is not limited to the small consumer of timber nor to those situated in isolated places. It is a process with which I am directly identified, and which has received my close attention. To the present time it has only been employed for the treatment of timber with oil. As a result of experimental work begun in 1906 I have developed a new process using the open tank method. It is a combination treatment, using a distillate of coal tar and sulphate of copper or zinc chloride, a two movement process which, while obtaining a treatment analogous to that obtained by the Allardyce method, leaves the surface of the tie in a cleaner condition. Tests made in co-operative work with a railway company have shown entirely satisfactory absorption and penetration. Owing to the incomplete state of the experimental data, no figures can be given at the present time.

Combination treatments employing mineral salts have heretofore been tabooed in the eastern and southern states where it is claimed that the moist and warmer climate causes a too rapid leaching of the soluble salts. The use of heavy tar oils acting as a plug to prevent the leaching of the salts to my mind fully overcomes this objection and I feel that we are to be congratulated in having Mr. Angier present his paper on this subject so opportunely as it sheds more light on a method which while perhaps not as efficient as straight tar oil treatment, yet has given such very good results that its more general use is destined to follow inasmuch as it combines efficiency with cheapness.

Mr. John Martin Schreiber, Engineer, Maintenance of Way, Public Service Railway Company, Newark, New Jersey. It is unfortunate that it is so essential to have such a long time element to show practical material results in the preserving of timber, and moreover that the records of what was accomplished as to methods followed, preservatives used and analyses of performance of the timber are not more complete and obtainable.

Without full information it is difficult to draw definite conclusions and show advantage of the treated tie over the untreated tie. Where the tie comes in contact with the ground the nature of the soil alone makes a great difference. I have seen taken up oak ties in fair condition, after 12 years in certain streets, and oak ties installed at the same time, in another part of the city, where the track was being reconstructed, it was possible to shovel out part of the ties as if they were earth. However if you place a well treated tie alongside of an untreated one, the same species and the quality of lumber on similar ballast or the same soil formation, and other conditions equal, from past experience you can bank on the properly treated tie as a desirable investment. And I have brought this out quite convincingly with actual figures and data from a large experience.

What seems to be of great importance at this time is not the kind of preservative used, as it would seem that we are fairly well fortified with a good specification for a coal tar creosote and for zinc chloride, or a combination of the two, but a closer study of methods and application. The novice is often surprised when treating even by pressure system to find that the wood is not evenly penetrated in the same sample, and that different pieces of the same species of wood do not show equal penetration or absorption, and often under a heavy treatment a portion of the sap wood of the same sample may be impregnated 35 pounds per cubic foot and another portion, probably a heart, not penetrated at all by the preserving fluid, not mentioning what is lost by dripping or over-saturation. Then we have lack of uniform results; for illustration we may again refer to the Texas experimental track, where treatment by the same process, efficiency varied as much as 20%, or perhaps by chance an analysis of preserving fluid shows a low grade of creosote oil, or from personal examination you find the liquid being forced back into the storage tank instead of the charge of timber. Nevertheless these differences are constantly being met, and show a great necessity of a thorough and proper classification of wood, and uniformity of preserving fluid and treatment.

The author very well shows the variation of absorption of the preservative in one of the tables and adopts a classification for different kinds of woods, based on the relative absorption per cubic foot. The classification is commendable, but should we not go further and take into consideration the portion of sap and heart wood, the rate of growth, elevation where grown, and the condition of seasoning? So after all it probably would be advisable in order to get the very best results to have a classification for each specie of wood.

Air seasoning is generally viewed with most favor and the bad results of improper steaming are realized, but here it might be well to take into consideration the preservative used. In Burnettizing or where a soluble solution is used, the quantity of moisture, if known, may be taken care of by varying the strength of the solution, which is not true with the insoluble creosote oil. Of course I realize that this limits practice but it seems there is an opportunity for further study and definite recommendation along these lines, if results are expected to be reasonably anticipated.

As to the open tank method of treatment, generally the process has received little consideration. This probably is due, more than anything else, to lack of experience. Admitting that pressure treatment is desirable and often justifiable, the open tank process has its field and even may be adopted to good advantage, and it also gives the small consumer a chance to treat his own wood. Imagine asking a consumer of say 100,000 ties per year, a good size electric road, to build a pressure plant at a cost of say, $40,000. You may say that such a small number of ties could be obtained already treated, but often the output is already purchased and any arrangement probably would involve a delay or a prohibitive cost. If thoroughly seasoned pine ties are only immersed in a hot distillate of coal tar for a period of say 30 minutes, favorable results may be obtained.

I have treated timber and ties in this manner and a similar method is now being used by the Denver street railway and the Salt Lake City street railway, and the results were favorably reported on after five or six years of trials, as late as last October at the American Street & Interurban Railway convention at Denver. Good results may be obtained by going further with the open tank method: first heating the ties in a hot bath with the preserving fluid, from say one to three hours, 220° F., and then immersing in a cold bath from one to three hours. In the able report of the committee on wood preservation of 1909 of the Am. Ry. & M. of W. association, it was said that, by the open tank method of treatment, a penetration of 1½" could be obtained. In this connection I wish to add that I have seen a penetration in sound and square edge yellow pine ties of three inches, and a treatment of 20 pounds per cubic foot in five hours by this method.

Summing up the subject it seems we may say (1) that it pays to treat ties. (2) A standard specification for coal tar creosote oil, a special distillate of coal tar and for zinc chloride is necessary. (3) That the process should be decided for each particular case depending on: (a) climate and soil conditions, (b) permanency desired, (c) time, convenience and cost. (4) That a reliable wood classification is needed. (5) It is important to have skilled labor to inspect and classify raw ties, analyze and check quality and quantity of preservative, and to intelligently and carefully supervise and record the entire work.

Mr. Angier—I think Mr. Sterling has answered nearly all of the questions asked much better than I could answer them; however, I will attempt to answer a few of the questions in the order in which they were asked.

Mr. Lamb stated that the Pennsylvania had planted many thousand trees. I merely wish to add that the Santa Fe is also one of the leading roads in this matter, and that it has planted in Southern California 1,500 acres of eucalyptus. The tree selected is a species of eucalyptus, indigenous to Australia, and for many years has been cultivated extensively in California. It is of very rapid growth and produces a hard wood, which by treatment may be made durable in contact with the earth. We are told that, under favorable conditions, a tie can be grown in about ten years; however, the eucalyptus will not be a tree of interest to growers of cross-ties outside of the southwestern portion of the United States, because winter kills it in regions subject to temperatures below 20 degrees F. The Burlington planted 110 acres of catalpa trees about four years ago. These were planted in Nebraska, and about two years ago an unusually severe hail storm damaged the small trees to such an extent that they were all cut off at the ground line. Characteristic of this tree, sprouts started immediately, and to-day many of the trees are 12 and 15 feet high, and two and three inches in diameter, with every indication of making ties in 20 or 25 years. The species planted is known as the speciosa variety, and not the scrub, or bignonioides.

Regarding the penetration of preservatives. In 1898, there was treated for the Burlington 25,000 hemlock ties, with what was known as the Seely process. The preservative used was heavy oil of coal tar or what we call creosote. The penetration was perhaps an inch or an inch and a half. The heartwood was entirely untreated. Four years after they were put in, about 30% showed a dry rot; after six years about 50% had to be taken out, and the balance were removed in about 10 years. Many of these ties crushed under the rails, and while that part penetrated by the creosote was still sound when taken out, it was not of sufficient depth to hold the spikes. It is practically impossible to get a heart penetration in hemlock or tamarack ties with creosote. The only way you can treat this class of wood and make it last, is to get a heart treatment, and the only way to get a heart treatment is to use a preservative that will penetrate the heart. Zinc chloride has a greater penetrating power than creosote. With a mixture of zinc chloride and creosote the zinc chloride will penetrate the heart of the wood, while the heavy oils of the creosote remain in the sapwood, thus preventing the leaching action of the zinc. With such a treatment we should get the mechanical life of hemlock, tamarack, and similar refractory wood used for cross-ties. We do not not want to preserve them from decay any longer than they will stand up under the rail from a mechanical standpoint. Why should we give a tie a 30 cent treatment if a 15 or 20 cent treatment will preserve it as long as it can be made to stand up under the rail with our present means of rail fastenings?

Sweet gum, or tupelo, is a very good wood for ties, if it can be treated soon after it is cut, but the objection to this species is that in seasoning, heart rot develops rapidly. A tie made from this wood may be apparently sound on the outside, but decayed to such an extent that it will break in two in dropping from a car. We have stopped buying gum ties on this account.

As regards seasoning, I think no argument is required. By far the majority of practical operators require seasoning; in fact, with some processes, seasoning is absolutely essential. With all processes, and with all kinds of timber that I know anything about, a much better penetration can be obtained when the wood is thoroughly seasoned. I have attempted to show that it is economical to season timber, rather than to treat it in a green condition.

In regard to ties checking open while being treated. In my ten years' experience of treating ties, I have seen but comparatively few instances where this has happened. I have photographed hundreds of ties showing checks before they were treated, and again photographed them after treatment, and in practically every case the checks closed in whole or in part. However, it must be understood that while these checks close during the treatment, they do not remain permanently closed, but will open again—unless prevented by using "S" irons—after the tie has seasoned.

As to the vacuum. Mr. Sterling well said there was no use in maintaining the vacuum for any lenght of time. A one hour, or perhaps a half hour vacuum may be all that is required, and with this, or even several hours vacuum, but a very small percentage of the preservative once injected into the wood can be withdrawn. The vacuum has practically nothing whatever to do in withdrawing the oil from the timber. It simply reduces the atmospheric pressure in the retort, allowing the air in the wood cells to expand, and a very small amount of the oil will come out. If you leave the timber in the retort for the same length of time without creating a vacuum nearly the same amount of oil will come out of it. A vacuum, by reducing the atmospheric pressure, correspondingly increases the boiling point, and thereby produces a more rapid evaporation, and practically all of the loss in the weight of the wood is due to this evaporation, and

not to the withdrawal and saving of the oil.

In regard to seasoning in cold vs. warm weather, there is absolutely no room for argument here, as it is conceded by nearly everybody that seasoning takes place much more rapidly in warm weather than in cold weather.

Regarding cypress; there are several species. What is known as red cypress does not require treatment, but the sapwood of yellow or white cypress will decay in a very few years. The practice on the Burlington is to give the latter a light treatment with the intention of treating only the sapwood.

As to the relative value of zinc and creosote treatments. Climatic conditions have much to do with this. If ties are to be used in a very dry climate, creosote may be entirely unnecessary. In Wyoming, South Dakota, and western Nebraska, a good zinc chloride treatment will, no doubt, give the mechanical life. If you can treat ties for ten or twelve cents each, and get the mechanical life, you certainly do not want to use creosote which is much more expensive; however, if the ties are to be used where there is a great deal of rainfall, it is well to use some creosote to prevent the leaching of the zinc chloride. Crude oil is used only as a plug to keep out moisture, and has no antiseptic properties.

I have not answered all of Mr. Hartmann's or Mr. Lamb's questions, as I failed to make notes of all of them. In regard to one statement made by Mr. Hartmann in which I understood him to say that in his test with the zinc-creosote treatment as compared to other treatments, it gave an efficiency of 19 per cent. Mr. Hartmann says 514 ties were treated with zinc and creosote, but he does not say how much zinc and how much creosote. If you are going to put in a pound of creosote and one-tenth of a pound of zinc per cubic foot, you had better not treat them at all, if the ties are to be used in a wet climate. In the eastern or southern states I would recommend not less than a half pound of zinc and five or six pounds of creosote per cubic foot of timber. If in climates such as Illinois, Iowa or Missouri, perhaps a half pound of zinc and three pounds of creosote would be sufficient.

Mr. Hartmann—Pardon me just one moment. I referred to the Texas experimental track, it is fully explained in the Government's forestry report.

Mr. Angier—I do not know much about this experimental track, but it is unfair to make comparison of the Burnettizing and straight creosote processes without giving the amount of preservatives used. If you are going to use the Burnettizing process why do you inject only a quarter of a pound of zinc chloride, and with the straight creosote process use eight pounds or more of creosote. When we speak of these treatments we should say how much preservative is used per cubic foot of timber.

For Mr. Schrieber's information, I will say that we do not attempt to classify heartwood and sapwood at the Burlington plants, because our ties all average pretty much the same in percentage of sap and heartwood. We do, however, classify the different kinds of wood. At present we have three classes, "A", "B" and "C." Class "A" includes all wood absorbing less than 22 per cent in volume, and in this class we have included the oak family, hickory, beech, hemlock and tamarack. We have found by repeated tests made with this class of timber, when seasoned anywhere between two and fifteen months, that it is very difficult to get a thorough penetration, and under only unusual conditions have we been able to get more than 22 per cent absorption in volume. Class "B" includes all woods absorbing between 23 and 30 per cent; such as gum, hard maple, ash, sycamore and poplar; and class "C" includes all woods absorbing more than 30 per cent, such as some of the pines, soft-maple, elm, birch, etc. Of course seasoned and unseasoned wood should not be treated in the same charge.

In regard to Mr. Emerson's question, I am unable, at this time, to give any information as to the percentage of ties failing from rail cut, spike wear, or other mechanical causes. We are, however, investigating this matter to some extent, and later may be able to throw some light on this very important subject.

In speaking of the cause of decay Mr. Sterling apparently refutes my statement in regard to the formation of bacteria in the wood, by decomposition of the albumen, but if analyzed his statement, which is part of the theory advanced by Mr. Von Schrenck, is not at variance with my statement, for it has for its primary cause fungus or bacteria, which sometimes forms on

TABLE OF RESULTS

I

Laid during Feb., Mar., Apr. and May, 1902. — Ties laid in Texas Experimental Tracks — Inspection Report Nov. 16, 1909. Inspection made Sept. 21 and 22, 1909

PROCESS	TREATED BY	TIES TREATED	SPLIT	UNSOUND	SHOWING DECAY	IN GOOD CONDITION	REMOVED	STILL IN TRACK	% IN GOOD CONDITION
Allardyce	T. T. & L. P. Co	499	93	44	56	276	30	469	55⅓
Wellhouse	T. T. & L. P. Co	513	27	40	29	175	242	271	34⅒ } 47%
Wellhouse	Octave Chanute	487	108	48	16	292	23	464	60
Burnettizing	T. T. & L. P. Co	514	51	21 Sp.K. 1 }	25	158	258	256	30⅘ } 40%
Burnettizing	Octave Chanute	434	100	61	23	216	34	400	49¾
Zinc-Creosote	Inter. Creosoting & Construction Co	514	21	7	..	72	414	100	14
Hassellmann	T. T. & L. P. Co	1066	2	7	10	28	1019	47	2⅔
Zinc chloride & Beaumont crude oil	T. T. & L. P. Co	180	52	15	6	107	..	180	59½
48 hrs. in Beaumont crude oil	T. T. & L. P. Co	142	..	Rotten 2 } 4	23	3	110	32	2
Immersed in Spirittine	T. T. & L. P. Co	200	3	....	2	17	178	22	8½
Sundry Process	A. T. & S. F. Ry. Co., W. A. Powers, Ch. Chemist	177	19	1	4	40	122	55	22⅗
Totals		4726	476 10%	251 5½%	194 4%	1384 27%	2430 51⅜ %	2296 48⅗%	

TABLE OF RESULTS

II

Ties Laid in Texas Experimental Track

Laid during Feb., March, April and May, 1902 — **Inspection report Nov. 16, 1909. Inspection made Sept. 21 and 22, 1909.**

PROCESS	WHITE OAK		OTHER OAKS		YELLOW PINE		SHORT LEAF		LOBLOLLY PINE		HEMLOCK		TAMA-RACK		BEECH		CALIF. RED-WOOD		
	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Ties Treated	% of Efficiency	Per cent. of Efficiency for all Woods
Allardyce	100	69	100	68	50	62	50	56	50	20	50	22	49	65.3	50	54	..	..	52 3/80
Wellhouse	201	50	199	37	100	35	100	19	100	49	100	66	100	72	100	51	10	00	47 3/8
Burnettizing	200	38	200	31	100	56	100	36	100	37	100	36	49	65.3	99	39.3	..	..	37 3/5
Zinc-Creosote	107	..	107	2	50	52	50	14	50	50	49	14.3	51	9.8	50	00	..	..	17.7
Hassellmann	196	11	177	100	100	5	98	.1	99	00	100	00	98	00	98	00	74	4	2 1/3
Zinc Chloride Beau crude oil	..	..	..	..	100	68	..	..	80	49	..	..	..	..	..	..	..	..	58 1/2
Soaked 48 hrs. Beau crude oil	..	..	..	..	100	3	..	..	42	00	..	..	..	..	..	..	..	..	1 1/2
Soaked in Spirit-tine	..	..	..	..	100	17	..	..	100	00	..	..	..	..	..	..	..	..	8 1/2

Per cent. of Efficiency calculated on ties reported in good condition.

the outside of wood, making punks or toadstools containing spores that are blown about and infect other wood. This is an effect not a cause. The fungus or bacteria often attack the center of the tree where no spores could be blown.

In regard to seasoning lumber: I wish to state that I have dried millions of feet board measure, both by air drying and kiln drying. My experience in air drying lumber is that it dries more rapidly in March than in any other month in the year. In hardwoods we often paint the ends to keep them from drying too quickly, which would split or check them.

Mr. Card: I would only like to call attention to Mr. Hartmann's paper. The ties he refers to on the Santa Fe which were zinc creosoted were all over-steamed. These ties were made brittle and crushed easily and they were removed from the track after being down but a very short time.

Mr. Angier: If you want good results from your treated ties, you must treat them right, and and if you are going to over-steam you cannot expect, nor will you get good results. You want an operator who is honest, and understands his business, then you will get results.

Mr. Hartmann: Perhaps I had better leave these two tables which I compiled with the secretary. From the official detailed report as it reached me it was impossible to arrive at any definite conclusions, and hence I prepared these tables for my own information. They are merely a tabulation of Mr. Faulkner's latest report on the Texas experimental track, and those at all conversant with wood preserving investigations should be familiar with this test track which has been so frequently referred to in government reports as well as in proceedings of the American Railway Engineering & Maintenance of Way association. To those desiring detailed information as to the treatment given these ties, I would suggest that they obtain bulletin 51 of the bureau of Forestry, U. S. department of Agriculture, written by Dr. Von Schrenck, and issued in 1904. To one familiar with the processes tested, the results in Table 2 must be rather interesting and conducive to sundry comparisons .

My closing remarks should clearly indicate my conviction that combination treatments possess distinctive advantages particularly adapted to American conditions.

Mr. C. A. Lichty, secretary, announces that it has been decided to change the place of the annual meeting of the American Railway Bridge and Building Association, from Fort Worth, Texas, to Denver, Colo.

Mr. H. Lavarock has been appointed signal engineer of the Federal Signal Co., at Chicago. Mr. Lavarock will have charge of construction.

The C. H. & D. has put in service three position, upper quadrant, automatic block signals on 15 miles of double track. This is in addition to 20 miles of single track, recently similarly equipped.

Mr. R. F. Annear, assistant supervisor of signals on the Lehigh Valley, has been appointed signal inspector on the Rock Island, at Chicago.

Mr. F. J. Bauman, assistant supervisor of signals of the Philadelphia division of the Pennsylvania, has been appointed supervisor of signals on the Renovo division of the same road, at Kane, Pa.

W. A. Beerbower, engineer of maintenance of way of the Denver, Northwestern & Pacific at Denver, Colo., has been appointed general superintendent, in charge of the operating, engineering and maintenance departments. (See an item under Operating Officers.)

C. E. Brinser, supervisor of the Pennsylvania Railroad, has been appointed division engineer of the New York, Philadelphia & Norfolk, with office at Cape Charles, Va., and J. H. Martin has been appointed foreman of signals, with office at Pocomoke, Md.

C. W. Power has been appointed resident engineer of the Grand Trunk, with office at Toronto, Ont., succeeding E. L. Cousins, resigned to go to another company.

G. E. Tebbetts, assistant bridge engineer of the Chicago, Burlington & Quincy, has been appointed bridge engineer of the Kansas City Terminal Ry. G. A. Haggender succeeds Mr. Tebbetts.

Report of Committee on Electrification*

The committee has made a careful study of this subject in the effort to look at it from all sides. It finds that there are some mooted questions as to system and details, and that there are many points upon which the average layman is somewhat misinformed and the meaning of which he has not a true conception. It has been thought wise, therefore, in this report, to make a review of the whole subject, though this may involve saying things which have been said before. The only excuse for this is to give railroad men, so far as your committee is able, a broad and comprehensive view of the present status of the electrification of steam railroads.

Some railroad companies operate electric urban and interurban lines. Under these circumstances, it probably would be very interesting to include a discussion of such lines in this report, but space and time forbid, and it was decided to limit the report to a discussion of the electrification of steam railroads as applied to terminals and trunk-line operation.

History.

The first successful installation in this country was made in Richmond, Va., in 1888, from which came the familiar trolley systems seen in our streets and highways.

In 1893 the Intramural Railway, at the Chicago World's Fair, first demonstrated the availability of electricity for heavier traction purposes than street trolleys. The distinctive feature of this installation was the first use of the third rail.

In 1895 the Metropolitan Elevated Railroad of Chicago was built, thus utilizing the principle which had been demonstrated by the Intramural.

In 1898 a considerable step was made when the multiple-unit system was first put into use by the South Side Elevated of Chicago. This installation displaced steam locomotives, which course was afterwards followed by the elevated railroads of New York city.

In the meantime some small electric locomotives had been used for mining, industrial and other purposes, but the first important installation of electric locomotives was by the Baltimore & Ohio in its Baltimore tunnel in 1895.

The next important electrical installation was by the Long Island in 1905, which was quite extensive in point of distance and in point of supplanting steam equipment.

In 1906 an important installation was made on the West Jersey & Sea Shore between Atlantic City and Philadelphia. The distinguishing feature of this installation was that it was the first approach towards main line express service.

In 1906 the electric installation in the terminals of the New York Central & Hudson River was put in operation. This, together with the New York, New Haven & Hartford installation, which was finished in 1907, is the heaviest and most complex situation which has yet been taken care of by electric traction.

In 1907, the first installation of the multiple-unit high voltage, single-phase system, as applied to former steam railroad practice, was made on the Rochester division of the Erie.

The first railroad to be built for the handling of both freight and passenger business entirely by electricity was the Spokane & Inland Empire, which was put in operation in 1907. This is probably the most extensive installation that there is in the country at present, handling both freight and passenger business. It is probable that the ability to utilize water-power formed quite a determining factor in the conclusion as to the use of electricity rather than steam.

In 1908 the Grand Trunk electrified that portion of its railroad through the Sarnia tunnel. This installation was put in for the purpose of handling mixed freight and passenger business, and it accomplishes the handling of heavier trains and the elimination of the smoke and other unisances attending the operation of a long tunnel.

In 1909 the Cascade tunnel of the Great Northern Railway was electrified. The distinguishing feature of this installation was the use of the three-phase system.

It is expected that during the present calendar year the Pennsylvania terminal installation in New York city will be put into operation—thus bringing into operation another important application of electricity.

It is to be noted that the installations above recited affecting steam operations were applied on account of special circumstances surrounding each case and that none of them involve heavy transcontinental trunk line service for any extended distance.

Characteristic Features of Electrification.

Flexibility.

A great variety of service is permitted by reason of the flexibility of the electric system. Locomotives may be used independently, or motors may be applied directly to the cars. Locomotives or motor cars may be coupled in a variety of ways, and operated by means of the multiple-unit system, from one point in the train, which applies in any system of electrification. Public streets and highways may be occupied, if necessary, and operation in tunnels cease to be objectionable. Trains may be shorter and more frequent, or they may be of any size that business conditions dictate consistent with mechanical considerations. A distribution of driving wheels throughout the whole train permits high acceleration, which in turn permits increased schedule speed without excessive increase in maximum speed. All of these features have a varying weight according to the circumstances of the particular problem at hand.

Effect of Weather Conditions.

Electric service has been found to be but slightly affected by snow or other weather conditions. It is well known, however, that a steam locomotive loses a serious part of its steaming capacity in cold weather, not to speak of the care, and consequent expense, necessary in such weather to keep the locomotive, while idle, in condition to operate. With steam, the problem is to keep the locomotive hot, whereas, with electricity, the problem is to keep it cool.

Use of Equipment.

It is a fact that an electric locomotive will have much less idle time, under the same conditions, than a steam locomotive. If desirable, the electric locomotive can be designed for practically continuous operation over any length of run. Many of the repairs, and almost all of its inspections can be made without the necessity of having to run the electric locomotive into the roundhouse, thus rendering unnecessary a large part of the round-house handling, and the possibility of having the continuous and immediate use of a locomotive, barring accidents, is very great. It should be noted, however, that while the electric locomotive is capable of almost continuous use, conditions frequently make such use impracticable. In the first place, much of the lost time of locomotives—particularly freight locomotives—is due to traffic and schedule conditions; and, second, while frequent visits to the round-houses may not be necessary, it may be desirable in order to increase reliability.

Power Capacity.

The maximum evaporating power of a locomotive boiler is constant, and, therefore, the maximum tractive effort cannot be maintained as the speed increases, and upon a long grade the element of human physical endurance enters in the person of the fireman. The electric locomotive, on the contrary, granting that the powerhouse is large enough and that the distribution system is arranged for it, can draw all the cur-

*To the New York Railroad Club. The committee: J. H. Davis, L. C. Fritch, E. B. Katte, Wm. McClellan, C. O. Mailloux, H. M. Warren, G. W. Wildin, W. J. Harahan, chairman.

rent that it needs to produce its maximum tractive effort. This feature, however, is somewhat counterbalanced by the fact that the amount of power that can be delivered at a given point depends upon the carrying capacity of the distribution system, which, in turn, is fixed at the time of installation. In case of a serious congestion, or accident to the power supply, the electric system is not as flexible as a steam system, composed of independent steam units.

Cleanliness.

It is only necessary to mention this feature to call attention to the increased attractiveness of the electric train whether running in the open or in a tunnel. In addition, the absence of destructive gases prolongs the life of station buildings and other structures, and preserves their attractiveness.

Collateral Advantages.

The absence of smoke and gas allows the utilization of property usually occupied solely by station buildings for additional purposes, such as office buildings, and many other purposes which will in itself produce additional net revenue. The current can also be used for the purpose of furnishing electric lighting and power for any purpose. Schedule conditions will usually allow switching, and perhaps some other portion of the traffic, to be done at times of light load.

Reasons for Considering Electrification.

Increase of Facilities.

When a road finds its trackage inadequate for its traffic, it must, of necessity, seek means to increase its facilities. The deficiency may be removed, depending upon what the cause is by adding to the number of tracks, by removing a "throat" or point of congestion, by reducing objectionable grades, by substituting tunnels for grades, by substituting open cuts for tunnels, by introducing locomotives of greater capacity, by the installation of signal systems, and by other means.

In addition to these various methods for the increase of facilities electrification should unquestionably always be considered. No general conclusions can be given, but not only are there numerous cases where carefully made estimates indicate electrification as the proper method to adopt, but several existing installations have accomplished expected results. This method of increasing facilities is especially applicable when a nearby waterpower can be developed at reasonable cost as compared with the cost of steam power.

Increase of Earnings.

Net earnings can be increased either by reducing the cost of operation, or by increasing gross earnings without a corresponding increase in operating cost. Under cost of operation, there is included in this discussion fixed charges as well as usual operating expense.

Under favorable circumstances the flexibility and attractiveness of electric service tend to increase passenger traffic, and, consequently, gross earnings. The abolishment of the time-table by more or less uniform train schedules, and the stopping of trains or cars frequently to suit the convenience of passengers, both develop the riding habit. This increase should only be counted on, however, after determining that the population exists, and that the necessity or possibility of its more frequent riding will follow. This would seldom, if ever, be a sole argument for electrifying a trunk line, and some suburban communities now have such a superb steam service that it is unquestionable whether the gross earnings would be greatly increased by electrification. This is especially true where there are existing parallel trolley lines which handle the strictly local service. It should be emphasized, however, that the mere substitution of electricity for steam will not accomplish a very great increase in gross earnings, but that by changes in schedule and stops, the service must be made more convenient and attractive to the desired patrons. Inattention to this feature is preventing some roads at present from realizing the full possible returns upon their electrification.

Under present conditions, it would not seem probable that the electrification of a trunk line railroad would produce any increase in gross earnings resulting from freight business, except, possibly, a slight increase in parcel business, which would be of such small consequence as not to have much influence in the problem. It would seem, therefore, that any pecuniary benefit to the freight business must come from decreased cost of operation.

It is unfortunate that your committee can present no comparable figures on which to base conclusions. Various statements as to operating expense are heard from time to time. It is probable, however, that this absence of data is an indication of the present state of the art. Your committee considered a large amount of data found in various magazines and technical journals, practically all of which, however, must be used with a feeling of uncertainty for the reason that all of the conditions surrounding their preparation are not given. Therefore, the committee formulated a plan by which essential information could be obtained of existing electrification. It found, however, that almost without exception, the men who were responsible for the operation of the properties did not think that conditions were sufficiently settled to permit them to publish data that would be just to either steam or electrical operation. Your committee is prepared to say, therefore, that no data which would apply in a general way is available. It is still necessary to wait before authoritative data, and useful information, from operating properties, can be obtained for publication.

Legislative Enactment.

The operation of a steam railroad in the heart of a large city is of necessity attended by features not always ideal. On account of the cost of land, and other conditions, the amount of space for roadway is likely to be cramped, and closely pressed by city, and private property. The emission of smoke and gases from the locomotives, especially if a subway or tunnel is involved, often leads the community to demand that the railroad abolish the objectionable features. This demand, in its essentials, may be reasonable enough, and if by calm and considerate discussion it can be shown that conditions are unnecessarily bad, the publis has a right to expect the railroads to provide a reasonable remedy. Unfortunately, however, the discussion is sometimes fanned into a condition where hostility and acrimony become the chief features. As a consequence, the public may make demands, the difficulty, expense and result of which it has no conception, and the railroad is compelled to refuse anything like the full extent of the demands because it knows it cannot afford to do otherwise.

In this connection, the following are a few broad considerations which common sense and equity present:

(1) A railroad has a charter franchise or special privilege from the commonwealth, and, therefore, belongs to a class of activities which must especially consider the interest of the public.

(2) A railroad is also a business venture organized to make money, and those responsible to the stockholders must conduct its affairs so as to serve their best ultimate interest.

(3) A nuisance, for example, smoke, incident to the operation of a property, whether factory, railroad, store, or what not, may be deplored, but all sources of such nuisances must be treated alike, and it should also be determined how far removing the nuisance might endanger the industry itself and cause its failure.

(4) It is only fair to assume that men who have worked in the public eye, at any particular business, for a number of years, are men of integrity, and well informed as to their business. Action should be taken, therefore, by the community only when advised by well-informed persons, and after comprehensive consideration.

(5) There are not two sides to this problem. The interests of the railroads and those of the public are one.

Cost Attending Installation.

The committee feels that it is advisable to discuss somewhat this question for the purpose of drawing attention to the various costs, direct and indirect. It is a fact that some of these costs are not always fully considered in studying the problem.

Direct Cost.

Under direct cost there should be included the cost of new cars, locomotives, powerhouses, sub-stations, etc., the cost of changes in old equipment, investments in land, water-power transmission lines, working conductors, etc. These are the costs which are usually estimated by engineers and frequently given as the so-called cost of electrification.

Contingent Cost.

This includes those uncertain costs, some of which can be anticipated, others not, frequently running into figures considerably above the estimated cost, and which, added to the direct cost, make the burden of electrification so serious. It covers the cost of changes in right-of-way, buildings, bridges, overhead crossings, changes in signal systems, telephone and telegraph, etc., and the interruption of service with the direct loss involved, the addition to the claim account due to accidents, particularly in connection with temporary construction, amortization of equipment and facilities, like coal, wood and water stations. If the electrification is for a small section of a large system, the equipment is simply shifted to other parts, but this expense is large nevertheless.

All changes that would increase the value of the road not necessitated by electrification, but merely made for convenience at the same time, should not be charged to the electrification.

Ultimate Cost.

There are, in addition to the direct and contingent costs, other costs which must be taken into consideration. These are due to the possible necessity at an early date for changes in apparatus as the art improves, requiring a complete substitution before it has served its natural time.

Systems of Electrification.

The following systems are now in use:

(1) Direct current, third rail or overhead, 600 to 1200 volts.

(2) Alternating current, high potential—three phase.

(3) Alternating current, high potential—single phase.

The storage battery, and gasolene-electric systems, have not up to this time been proposed for heavy work, but merely as adjuncts to steam and other electric systems, and therefore will not be further considered in this report.

So far as the purely technical features are concerned, it may be asserted positively that any given electrification problem can be solved by any one of the three methods mentioned above, and the results will be reliable.

The difficulty of choosing a system for a given electrification, arises from the fact that one system which may be adapted to a particular situation may not be as suitable for trunk line work with its variety of freight and passenger service. When it becomes necessary to electrify either a whole system, or an extended part of it, the difficulty of choice of system will vanish for the reason that the settlement will be wholly on the basis of cost of operation, including fixed charges. So far, electrification has generally been applied in trunk line steam railroad service only where physical restrictions, such as tunnels or heavy grades, occur. In such places, as soon as it was determined whether the problem was a local or an extended one, the question of system was soon solved.

The direct current railway motor is better than the single phase railway motor of today, but for long distance work, the distribution system for single phase system is simpler than the direct current system.

The three phase system, requiring two overhead wires—used by the Great Northern in the Cascade tunnel, employs a constant speed induction motor, which is very sturdy and simple mechanically. Unfortunately, the two overhead wires or third and fourth rails (if temporary low voltage must be used in city streets, tunnels, railroad yards and the like) would, in many cases, render this system objectionable. Moreover, this motor cannot work on direct current so that a combination of alternating and direct current systems could not be arranged should it seem necessary. In cases where a constant speed is desirable this system will have a strong position.

The principal systems of electrification used in the United States are the direct current system and the high potential, single phase system. Frequently the difference in the estimated cost between these systems, considering both first cost and cost of operation, is so slight that the decision cannot be made on a cost basis alone.

It seems to be acknowledged that for extended trunk line work, a high voltage working current is desirable. It is in this service that the single phase system which permits the use of an 11,000 volt current, or higher, has peculiar advantages. It cannot be predicted, however, that a high voltage direct current system cannot be developed for this work. So far, 1,200 volts is the highest that has been used in this country, though higher direct current voltages have been proposed.

It should be emphasized that these systems must be compared in all their aspects because no one system in all its parts is superior. As stated above, there is no difficulty in selecting a system for either a purely local situation, or for an extended electrification, but the difficulty arises when a comparatively small zone must be electrified, and a system chosen which can be economically extended later.

Advantages and Disadvantages of Electrification.

To sum up, the following may be stated as the advantages and disadvantages of electrification.

Advantages.

(1) Increasing the capacity of a given terminal by the elimination of switching movements, where multiple units are used, and increasing the scheduled speed of trains without increasing maximum speed by the higher acceleration possible with electric power; also increasing the capacity of the line and permitting shorter block signal spacing.

(2) Avoidance of smoke and steam nuisance, making unobjectionable tunnels, subways, and underground stations, and reclaiming the aerial space above tracks for offices, stores, warehouses, hotels, or other buildings; also a saving in deterioration of metallic structures because of the corrosive products of combustion in steam locomotives.

(3) Uniform power over grades and greater tractive power of electric locomotives of equal weight with steam locomotives including tenders, making heavier trains possible over mountain divisions. Locomotives may be used in multiple without increasing the cost for enginemen.

(4) Economy of operation under conditions favorable to electric traction, such as frequent multiple-unit train service or cheap electric power as compared with the higher cost of locomotive coal.

(5) Electrical operation has proved itself reliable.

(6) Electric power is not a source of danger to the traveling or general public.

Disadvantages.

(1) A large investment for re-equipping the railroads with the new power which can only be justified by definite financial or economic results.

(2) Increased danger to employes or the railroad due to the presence of the third rail or the overhead conductor, especially in yards or terminals.

Features to be Considered for Future Electrification.

The following features with reference to present conditions should be considered, having in view future electrification:

(1) The signal systems should be designed with a view of meeting the restrictions involved in electrification work.

(2) Bridges, yards, and terminal platforms, should be designed to conform to the clearances necessary for the installation of working conductors.

(3) Locomotives and cars should be designed to conform to electrification clearances.

(4) The lighting system of cars should be designed for economical use on electrified roads. This applies also to the heating systems.

(5) Steam, water, air, and gas-pipes, in yards, and at stations, should be laid out to avoid current collectors on future electric equipment and working conductors, also bonded to avoid electrolysis.

Conclusions.

(1) No general information is available on the basis of which steam railroads, as a whole, would be justified in electrifying terminals or main lines, solely on the grounds of economy.

(2) Careful investigation is necessary to decide if electrification of terminals and suburban districts would be warranted in order to increase earnings.

(3) More attention should be given to the possibilities of electrification in connection with heavy grades, and at other places where an increase in facilities is needed.

(4) It is not likely that conclusive data on the economy of electrification will be available until electrification is extended over a complete steam locomotive stage.

(5) The electrification for passenger terminal and suburban service is now more or less settled as to method, but for freight and general trunk line service it is in the experimental stage.

(a) The types of locomotives for various service have not been determined, though progress is being made.

(b) The method of secondary distribution (working conductors), needs much development. The third rail is thoroughly reliable and efficient, but unsuitable for complicated switch work. In its present form it has only been used for voltage up to 1,200.

(c) Th overhead system for high voltage working conductors also needs much development. Few, if any, are satisfied with present designs, and many changes are proposed.

(6) The steam railroad men and electrical engineers should work together in as close harmony as is possible so as to produce results that will be as free from mistakes and experiments as is possible in any developing art.

(7) Each problem must be studied on its merits and a decision can only be made after careful study of the conditions pertaining to each situation.

(8) The electrification of large freight terminals has not as yet been attempted, nor satisfactorily worked out, therefore it is necessary to proceed with caution in this matter and the problem must be exhaustively studied and new developments made before it would be justifiable to make such an installation. The electrification of any large freight terminal would involve a number of roads, and cannot be undertaken independently, without the co-operation of all the railroads affected, on account of the relations existing among the various roads in the interchange of freight traffic.

DISCUSSION.

Mr. Gibbs: In discussing this subject at our 1907 "electric evening" I made some statements as to comparative operating costs, steam and electric, on information then obtainable, to the effect that in few cases only can the actual saving in operating expenses be expected to pay the interest on added investment required by electric traction, much less a profit besides; the saving may be large, but so is the added interest charge. I said that we should look to the collateral advantages of electric traction in addition to the question of relative operating costs in deciding on the adoption of the new method. These conclusions in general still hold good according to my experience. In a report to be read at the International Railway Congress in Switzerland this summer, I have discussed the present condition of electric traction in America, and have given tables for relative operating costs between steam and electric, covering a two years' period on the Long Island and on the West Jersey & Seashore. These installations, as you know, are important and extensive, one, the Long Island, representing a dense suburban business, and the other, the West Jersey, a moderately dense suburban and long distance express passenger service. The figures given in this report will soon be made public, and I expect, in contributing a discussion, to add comparative figures for a third year, just closed. They show that in a dense suburban service a large saving in operating expenses can be expected by electric traction, sufficiently large to pay interest on the added investment with a good surplus to spare; also, that the capacity of the lines and terminals has been largely increased, operating methods simplified, and business attracted to the electrified lines. The figures show that for a long distance express passenger service a saving, but a small one, is secured by electric traction, but that the mileage in such service was too small to enable the saving to pay full interest on the added investments. In this service electricity is competing with the most economical kind of steam service: that is, long distance rather heavy trains at high speed with few stops. The collateral advantages also, in such cases, are not as great as for a local service. That is, long distance travel cannot be induced beyond a certain point and electric traction has no special advantages from the passenger's standpoint, the speed and comfort not being appreciably greater than with steam.

These cases cover probably the only ones in this country in which electric operation has been used long enough or is in a stable enough condition to enable comparative operative results to be given, but I think publication of detailed results on the two roads will be of real service to railway men, as the operation has been continued over a long enough period of time to give us a pretty clear idea of the possibilities of electric traction in this particular kind of service, its weak points, and the average upkeep figures for each part of the equipment.

Broadly speaking, on Long Island we are extremely well pleased with our electric operation, and the collateral advantages in handling a dense suburban service over a rather complicated network of lines and into expensive terminals are showing themselves more strikingly year by year. We are also pleased with the particular traction system we are using there, which is giving us very little trouble outside of the usual maintenance routine.

In speaking of the character of the electric system to be adopted, I think it is not out of place to call the attention of electrical engineers and manufacturing companies to the unfortunate impression made upon the minds of practical railway men by the attitude sometimes taken by experts in discussing electric traction. The railway manager is actively engaged getting the best results out of what he has and making such improvements as he finds it possible to secure money for, and he dislikes the setting aside on a large scale of serviceable equipment for something new involving radically new maintenance features, especially when he is going from something he knows about and is used to, to something which he can know little about. It is unfortunate, therefore, if he should get the impression that electricity is still in the experimental stage, and he does get this impression when he hears

one system advocated as the only practical one by a certain set of engineers, and another as the only practical one by another set. The fact of the matter is that no system proposed is free from its peculiar objections, and each has its merits; something better than any one now used is to be desired, but at least two systems are good, reliable and efficient. One system is best for a particular set of conditions, another for another set of conditions. The main questions are:

(1) Is electric traction suitable for railway use?
(2) Is it safe and reliable?
(3) What will it accomplish?

We can, I think, safely say that electric traction is suitable for operating any kind of railway service, and that in general it is safe and reliable and can be made to fit practically any general case; which system to be used depends upon the elements of the case, a subject to be carefully considered by the practical railway man with the help of a technical expert.

As to the beneficial practical results, especially the economic ones, these will vary with the case under discussion; in some cases they will be sufficient to warrant the adoption of electric traction with great benefit to the railroad company; in others they do not offer any great inducement; and in still others they would be distinctly detrimental and uneconomical. The committee has called attention to its adaptation to freight business, especially in large freight terminals, and urges caution in this respect. The practical data which we have on haulage of heavy freight trains, especially as regards the distribution of current to the trains in complicated yards, is very limited and must be worked out gradually, to be done properly, safely and economically.

It is to be hoped, therefore, that legislative enactment will not be called into play at too early a date in this new art. I believe railways can be depended upon to take up these problems with all advisable expedition and should not be forced to adopt plans based on imperfect practical information. The art is very new and must go through the development period before general or extensive special application is to be reasonably expected.

Mr. Stilwell: The fact that to-day we have no trunk line service electrified and operating freight as well as passenger service is impressive but not discouraging. The same kind of reasoning, the same process of deduction from known facts that have led to a successful electrification of terminals and of electric zones where traffic is highly congested are applicable with the same certainty to the conditions governing freight transportation and other transportation on trunk lines. I sympathize very thoroughly with the idea expressed in the report of your committee that this problem must be worked out by co-operative methods between steam and electric engineers. There is no reason why a man who begins the study of the problem as a specialist in electrification cannot come to know and competently analyze problems of railroad transportation just as well, and in some respects better, than the man whose entire experience has been limited to the operation of railroads by steam. In the case of the latter the disadvantage imposed by the incessant and responsible duties which fall upon the operating man is a serious one. In my opinion the data of the steam railroads present no mysteries which cannot be traced to their source, and they are quite as apt to be run down by the man who starts from the outside as by the man who has dealt with them from the inside so long that he has come to accept as inevitable conditions which are far from ideal and which in the present state of the engineering art are capable of correction.

There is no doubt that the question, whether it will pay to electrify any given trunk line, can be answered to-day with very close approximation to the actual results which will be realized in practice. In the past three years our data, based upon actual results, have been largely increased, and it is comparatively a short step to figure now from the known to the comparatively unknown in this field. For example, in the case of any given railroad or division, the actual fuel consumption under steam operation can be ascertained from the records, and it is a simple problem to work out within say 5 per cent of possible error the fuel consumption for equivalent electric operation.

In the electric railway field the most important problem to-day is the development of standards essential to interchange of traffic. In this country our method of special solutions for each case of electrification is certain to lay up a large store of vexation, expense and criticism in the not distant future. The German method, as you probably know, is different. The experts of the Prussian government, for example, having carefully investigated the subject, have definitely adopted for the electrification of the state railways the single-phase alternating-current system at 15 cycles per second and 10,000 volts on the trolley.

Standardization cannot be brought about in this country at present by governmental action. It must be evolved by the American Railway Association and our engineering associations working in co-operation.

Two years ago, in a paper read before the electrical engineers, I suggested that we ought to standardize at least three things: (1) the location of the third rail; (2) the location of the overhead trolley in railway work, and (3) the frequency at which the alternating current, in the case of A. C. systems, is used. That suggestion encountered strong criticism from various directions.

A standard location of the third rail has not yet been agreed upon. Some day it must be. We have had many special solutions; for instance, here in New York city in the subway we have a third rail which is 23 inches from the gauge line and four inches above the rail head. The Long Island uses a third rail 27½ inches from the gauge line, 3½ inches above the rail head. The New York Central made an important step in inverting the rail, but the location is neither that adopted by the subway nor that used by the Long Island. Moreover, the location chosen by the New York Central does not permit the operation of certain kinds of rolling stock over the tracks which are electrically operated. The West Shore, in electrifying its tracks in central New York, adopted a location different from all those to which I have referred.

The overhead trolley has been located by the New Haven and I earnestly hope that any other railroad that may adopt the single-phase system in this country will not select any different location except for reasons absolutely controlling. We can all see that the location of third rails and trolleys may become as important as track gauge has been in the past.

I am glad to say that in respect to the other suggestion to which I have referred, namely, frequency, substantial progress has been made. The two manufacturing companies in America which are most active in supplying electric apparatus for railways are now in agreement that for trunk line operation by single-phase systems the frequency should be 15 cycles per second. This, I think, is a substantial step forward.

There is one other thing to which I should like to refer, and that is that the railroad companies should wake up and by timely and conservative electrification prevent the construction of electric railroads paralleling their lines. The railroads, generally speaking, are able to electrify more advantageously and at less cost than the competing line. In Indiana, Ohio and Illinois the interurban electric lines aggregate about 25 per cent of the total steam mileage, and 17 per cent of the steam mileage is closely paralleled by electric lines.

Many of the steam roads affected would find it more economical to electrify their branch lines and build up this

Fig. 1.

interurban traffic in connection with their own system than to allow the trolley lines to come into the field and take it away from them.

Mr. Murray (N. Y., N. H. & H.): Fig. 1 is a part of our East Portchester yard and the ten-track catenary span is seen in the foreground. The yard extends on up some three or four hundred yards and ends in a single track at the head of the yard, showing that the cross-catenary system is subject to considerable flexibility in the number of tracks covered.

Fig. 2 is a view of our new construction, showing the erection of a cross-span supported by the main messenger cables. It differs from the original construction in that the top catenaries are grounded.

I have shown Fig. 3 to indicate the old form of construction, the triangular scheme of suspension, the distance of the span in this case being 300 feet.

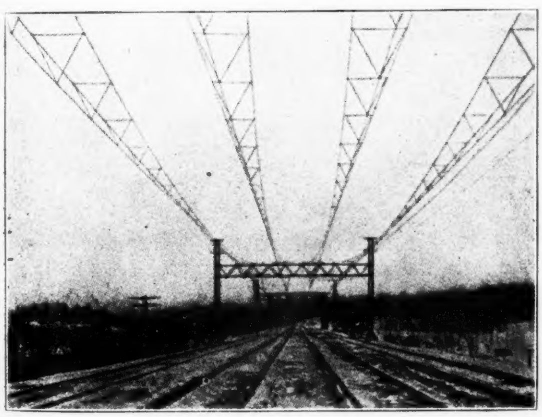


Fig. 3.

Fig. 4 is a picture showing the new form of electrification. You will note in this picture that the main messengers are here—from which is supported the cross frames. These frames are separated 100 feet. Again are seen the gorunded messengers. The system of grounding offers two very good points—the first one being that it eliminates to a considerable degree lightning effects, and the second, it permits the painting of cables without removing the current from the lower wires. Here you see what might be called the electrical messenger. From it is suspended the copper wire and then from it the steel contact wire with which the pantagraph of the locomotive makes contact.

I wanted to a get a good close view of the hanger used on curves (Fig. 5). The catenary is on a two-degree curve. This is the insulator with its messenger going off to its 100-ft. attachment and the hanger comes down to the center point of this clip, the top of which holds the copper wire, and the lower the steel contact wire. They are so suspended that on curves the wires are in the same vertical plans. If you will study the picture for a moment you will see that the chording effect—that is, the tendency of the wires to follow a straight line instead of the curve—gives equal horizonal components in each wire. Thus, if these equal components are restrained by a clip held at its center point, the copper and steel wire must remain in a vertical plane on curves.

Fig. 6 is the catenary construction on the two-degree curve that I spoke of. This track has the vertical clip hanger. The other three tracks have clips not supported at their central point and show the wires not in a vertical plane.

Fig. 7 shows our first multiple unit train on the new electrification. It is a six-car train, with two motor cars. They carry the schedule with great ease and acceleration. Each car seats seventy-six people.

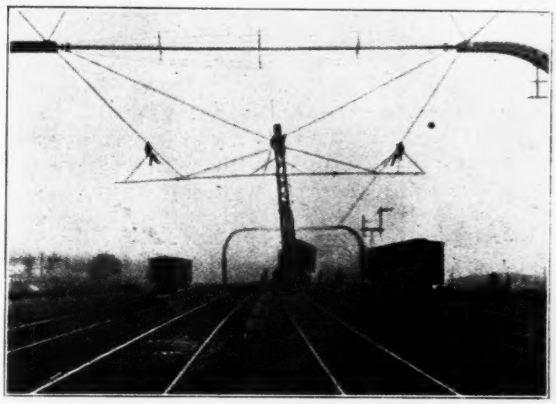


Fig. 2.

In reading over the very interesting chronological history of the electrical development, with reference to heavy traction, it occurs to me the engine we have recently received, while not yet placed in official commercial service, might be worthy of notation. This engine is of the single-phase type, arranged for 11,000 contact wire voltage, with four driving axles, each twin-geared to a motor. This locomotive is designed so that drivers are slipped at 51,000 lbs. tractive effort, this also being within the commutation limits of the motors. This electric locomotive is an experimental machine, but has been operating in commercial service on the N. Y., N. H. & H. rails, having accomplished already about 2,000 miles in freight runs. It will handle with ease freight trains up to 2,000 tons, and its speed characteristics are such as to

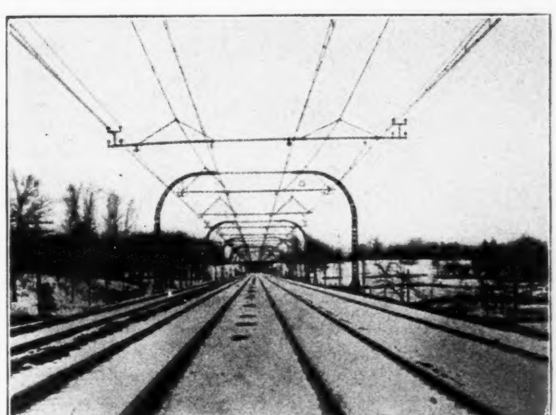


Fig. 4.

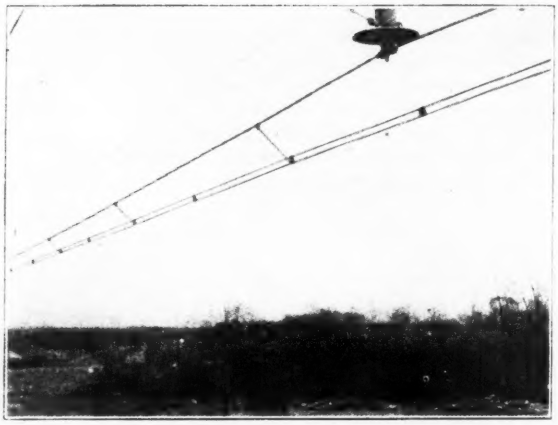


Fig. 5.

permit the operation of 800-ton passenger trains at 45 miles an hour.

Under this heading "Power Capacity" it is stated: "The electric locomotive, on the contrary, granting that the power house is large enough and that the distribution system is arranged for it, can draw all the current that it needs to produce its maximum tractive effort. This feature, however, is somewhat counterbalanced by the fact that the amount of power that can be delivered at a given point depends upon the carrying capacity of the distribution system, which in turn is fixed at the time of installation." The mechanical necessities of overhead suspension, conductor and contact wires in the high voltage system brings such a large carrying capacity as to provide against any such contingency as the limitation of power transmitted through the distributing system. Notwithstanding that the outlay of copper in the case of the single-phase system of the New Haven road is but a small per cent of the equivalent copper which would be required for the same line efficiency in a direct current third rail system, there has never been a moment when the distributing system installed has not been able to furnish strong voltage over its complete line, or to put it in another way, no complaint is on record by electric locomotive enginemen where their schedule was not made, due to low voltage, or again, it might put the situation more clearly to say that on our busiest day (e. g., football day at New Haven), the distribution system has been required to keep in motion simultaneously trains totaling approximately 10,000 tons. I was interested in determining the actual voltage drop of our system during peak conditions, and voltmeter readings were taken at our Woodlawn Tower, the farthest signal tower from our power station (some 18 miles). The lowest recorded

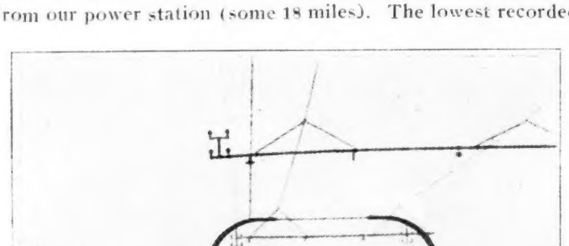


Fig. 7.

voltage was 9,800, the general operating voltage of the line being 11,000. These statements, however, would come well within reasonable expectation, as the average loss throughout the day for the lines is less than 5 per cent.

Under the heading "Collateral Advantages," I read the following: "Schedule conditions will usually allow switching and perhaps some other portion of the traffic to be done at times of light load." While this is classified under an advantage, the condition that it carries seems to imply a disadvantage. Our experience shows that switching, on a commercial basis, requires from 6 to 10 per cent of the total power. Any power station and distribution equipment should with ease take care of all switching, irrespective of the time in which it is done, as this super-addition of say 10 per cent to the regular main line power requirements ought to be easily taken care of by the overload capacity of the power houses and line. I am thoroughly in agreement with the committee's conclusion in its assertion that any pecuniary benefit to the freight business by electrification must come from decreased cost of operation. In connection with this it is interesting to note that, generally speaking, the power house equipment will not have to be increased for the handling of freight, as this particular schedule can be, as is now customary, handled at night, the principal passenger schedule being handled during the day. This combination will bring a much better load factor to the system throughout.

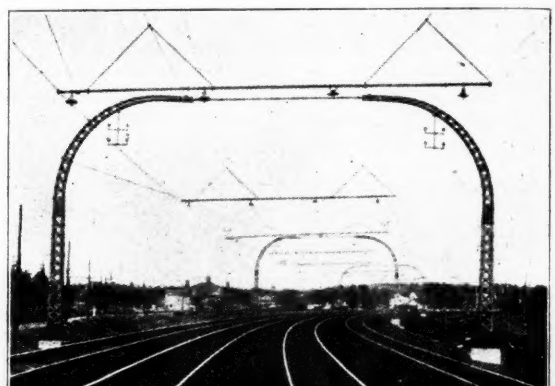


Fig. 6.

Another great factor in reducing operating cost in handling freight by electricity will be in the ability of the electric equipment to handle longer and faster trains, thereby reducing materially the aggregate train miles, one of the greatest fields in which to practice economy. Also it is worthy of mention that 100 per cent steam engine units can be replaced by 60 per cent electric engine units.

With apologies to the committee, I view with mournful eye the terrible arraignment under contingent cost. Far be it from me to say that there are not expenditures other than the direct cost of electrification, but analyzing the citation in the report:

For example, the right of way of the New York, New Haven & Hartford, except for a few pier rights which had to be purchased, is to-day as it existed before the trains were operated by electricity. There are few railroads whose right-of-way limits are not entirely sufficient to cover the erection of structures necessary for supporting electrical feeders and contact conductors. To be sure, we have not been required to acquire land for sub-station. We have not been required to make any changes in buildings; on the other hand, they have become more valuable to us. We have not been required to change any bridges; these, in turn, have become more valuable to us, on account of a more even traction over

them. Overhead crossings have not added to our list of expenses. It is true that our signal system has been changed due to electrification, but these changes have, at the same time, increased the track capacity and reduced the original operating expense to such an extent that the money saved in operation has practically offset the investment charge. It is true the telephone and telegraph have been affected by the single-phase system, but the correction is not a serious or menacing cost. We do not find any claims of patrons on our books on account of accidents, due either to temporary or permanent construction.

Electrification cannot be applied economically to trunk lines except those whose density of traffic is such as to bring a return for capital outlay. As stated by the committee, amortization of equipment such as locomotives and cars is taken care of by their being placed in other service. Coal, wood and water stations are too insignificant for consideration.

It would, therefore, seem to me that we should be cautious in making an array of costs, if with them there is not included their complementary credits. For example, under contingent cost there is mentioned the changes in signal systems, but in the closing paragraph under contingent costs it is advised that "all changes that have increased the values of the road, not necessitated by electrification, but merely made for convenience, at the same itme should not be charged to the electrification." It seems to me that the change in signals is covered by this last clause, so why does change in signals appear in contingent cost?

(To be continued)

The Maintenance of Way Department

Editor, Railway Engineering:

My experience in draining cuts is to make a ditch with the inner edge 7 ft. from the nearest rail, and the outer edge 9 ft., and the bottom of the ditch 28 in. below the top of the rail. Ditch to have a slope of 1½ to 1.

In bad wet cuts, the best method of drainage is to use a drain tile, put in to a depth of 3 ft., or below the frost with a fall of 3 in. to the hundred feet, tile to be covered over with about 12 in. of cinders, and then shape a small ditch on top of drain to draw the water from the track into the tile. This will also have a tendency to stop slides in cuts. It might be well in order to prevent slides in cuts, to make surface ditches on the top of the cut, at least 8 or 10 ft.

Michigan. General Roadmaster.

Editor, Railway Engineering:

I have found that tile is the only sure way effectually to drain wet cuts. I have frequently used a 12-inch coating of cinders on the sub-grade both in laying new tracks and when cutting down grade in old tracks and with good gravel ballast on top it would make good track for a few years with surface ditches. With heavy traffic, however, mud would commence to come up in a few years. Tile properly put in with frequent inlets for the surface water, carefully looked after so as not to allow them to clog up, is the best investment that any railroad can make in improving its roadbed today. It saves much hard track work in all seasons and adds to the riding quality of the tracks. Numerous places on my division that would heave in winter and cause section men to alter the shimming every morning in severe weather have been eradicated by under drains so that we do not notice them at all now.

I have also stopped sliding cuts or embankments by cutting trenches, not straight up and down, but at an angle of forty-five degrees, filling them with rough stone and boulders to a depth below the slide line and covering them over and sod or seeding them and have no more trouble. I am an advocate of drainage for track, switch lay-outs, large yards, etc., and can demonstrate their efficiency, in many instances far exceeding the original expense of installing them.

New York. Supervisor of Track.

Editor, Railway Engineering:

On our line of road we are not troubled with wet cuts and of slides in cuts, and I have no experience with this trouble, therefore cannot say as to the merits of tile, cinders, etc.

Pennsylvania. Supervisor.

Editor, Railway Engineering:

In regard to relative merits of tile, ditches, cinders or any combination of the three for draining cuts, we use all three of these methods, but find a combination of cinders and porous tiling the most effective. We place this tiling two feet below the surface of the ditch and fill completely around it with cinders, carrying them to the surface of the ditch. This makes as perfect drainage as anything we have ever found. For the sides of slippery or clay cuts, we also use cinders, starting them at the bottom and covering the entire face to a thickness of about 4 in. This holds the clay in place and the cinders are not thick enough to hinder the grass roots from taking hold, and gradually the bank becomes solid and does not slide.

Massachusetts. Roadmaster.

Editor, Railway Engineering:

I have not had much experience with sliding cuts, except one 30 ft. cut with slanting rock in bottom. I mastered this very easily by drilling a 6 in. square hole 4 ft. deep and placing 8 ft. rails in it 4 ft. apart and filling hole with concrete and placing old bridge stringers behind the rail; have had no further trouble. For earth in bottom of a bad cut, you should drive piling and place old bridge stringers behind the stringers lay several rows of tile, if bad cut. I have tiled some cuts with good success.

Indiana. Roadmaster.

Editor, Railway Engineer:

The most essential characteristics of a good railway track are accurate gauge, true line, smooth surface and tight joint fastenings. Suppose we have a new piece of track, with new rails, good sound ties, and ballasted with earth, sand, cinders, gravel or rock; but have neglected to give this track a sufficient drainage system. The track will settle unevenly and to a great extent your ballast will be wasted. Soon the joints will be churning, and the rails become surface-bent. The track will develop a weak and low place on one side, and perhaps a rail length or two further ahead the other side will be low. Should those low places now be raised owing to lack of proper drainage, the ballast would not be in proper condition for tamping, so the trouble would only be increased. A few more trains over it (especially during wet weather) would bury the new ties still deeper in the roadbed, and the swinging motion of the train would tend to pull the track out of line. When the ties have become old (or even new ones made of soft wood) thy will then also not hold the spikes, and the track would be found to be out of gauge, especially at the joints, which are the weakest points. In short, the once perfect

track will now be a dilapidated affair—a track in name only. And this, because of neglected drainage. While it is true that in fine sand, cinders or such material the track can be kept to surface better than in dirt ballast, a good trackman will first attend to track drainage nevertheless. If you neglect to drain your track, then any other work done on it is for the most part wasted.

There are some good trackmen who realize the importance of perfect track-drainage, but who would like to take advantage of the good weather so as to improve the surface of the track. These men will never think of ditching until it begins raining, and then, before they get well started with their ditching-work, track surface on which the men had spent several weeks' work, will be ruined. It is our duty as trackforemen to maintain a safe and smoothriding track at minimum expense. Another class of trackmen try to ditch a cut by throwing material part-way up the slope of cut, where the first heavy rain will wash it back again and fill up the ditch. Another bad practice is to start ditching at the upper end of the cut instead of at the lower end. In most cases a foreman with four track laborers may do fairly good work at ditching cuts, by taking a pushcar and dump boxes, start at lower end of cut and be sure to have the outfall so far away from track that water will not have any chance to undermine it. Work both sides of the track at the same time and be sure not to gouge any holes in back side nor bottom of ditch. Haul out material on fill and by using the dump boxes you need not be troubled about trains catching you with a loaded car. You will do well, however, to keep a slow flag out for extra trains, but keep off of the time of regular trains.

Texas. Foreman.

Editor, Railway Engineering:

In the matter of drainage and roadway cuts, my experience has been with ordinary drain tile, one-fourth in length, laid at the proper depth which is ordinarily about three to four feet below the top of the rail, covered with coal cinders, coal slack, refuse rock, or something of this nature to allow the water to spread through the tiling has proved very satisfactory. Of course cinders or crushed rock laid in trenches answers very well when there is not a great deal of water to be taken care of.

In my experience in taking care of sliding cuts and fills, has been, if not too bad, that it is a good plan to trench the fill and fill it with rock, placing the trenches from 30 to 50 or a 100 feet apart, as the occasion may require. In the case of a cut or fill, or in other cases, after the drainage has been cared for in this manner, the surface should be taken care of, by sodding with Bermuda grass, which after it once gets well set will prove very satisfactory. The best way to get the Bermuda grass set, is to transplant it instead of getting it started from the seed.

Oklahoma. Roadmaster.

Editor, Railway Engineering:

We place tile below frost line in ditches of cuts, placing the tile on about one foot of cinders and covering with two feet more, filling remainder with earth, pains being taken to give tile sufficient fall to drain by having stakes set by Civil Engineer. The placing of this tile prevents banks or sides of cuts from sliding to large extent, besides almost entirely preventing track from heaving, thus avoiding and saving the cost of shimming to say nothing of accidents which occur from this cause. This feature alone, in my opinion, more than justifies the expense of establishing drain tile in this part of the country.

As to providing drainage for sides of cuts to prevent slides, we establish surface ditches wherever possible on tops of cuts which if maintained are more help than anything that I know of to prevent side of cuts from sliding. Seeding and sodding of sides of cuts is also a good thing. It has also been found that the refuse from cleaning of stock cars is a good thing to place on sides of cuts. It absorbs water in summer, produces vegetation and prevents frost from entering in winter, which adds greatly to prevention of slides in spring which is the worst season for this trouble, especially in northern country.

Wisconsin. Division Roadmaster.

Construction

Construction work on the doubletrack line from Pueblo, Col., to Walsenburg for the Denver & Rio Grande and the Colorado & Southern is about to begin. This new line will parallel the Rio Grande's old singletrack line between these two cities for the entire distance, but will have the advantage of lower grades and fewer curves. The Utah Construction Company, which is collecting its forces and equipment preparatory to pushing the work along as rapidly as possible, is the same company which recently built the Western Pacific, the Gould extension from Salt Lake to San Francisco.

Engineers estimate that the new line will cost in the neighborhood of $4,000,000. The road will be 46 miles long and construction is expected to be costly and difficult. It will be necessary to excavate about 1,250,000 yds. of earth, 37,000 yds. of loose rock and 500,000 yds. of solid rock. Besides this immense amount of excavation the material from which will be used in fills, it will be necessary to secure 3,100,000 additional cu. yds. of earth to complete the fills.

The work of changing the channel of the Calumet river at Gary, Ind., is nearing completion. Stein & Lamb, the contractors, have been at work on the channel for several months and have employed on the work upwards of one hundred men, three steam shovels and a multitude of dinky engines, cars, horses and other equipment. The channel which they have excavated runs directly east from the river at the Broadway bridge to a point 1 1-2 miles away at which it again joins the old river bed.

At the present time there are two steam shovels at work in the channel. Both of these shovels have been equipped, from time to time, with the latest appliances for moving dirt and sand and have been kept incessantly at work. There are four trains at work constantly taking away sand dug from the channel by the shovels and transferring it to the old bed of the river and the marshes with which it was surrounded.

In addition to this channel work this firm of contractors, which was the first to move sand in Gary, is doing the work on the new extension of Fifth avenue east to Aetna. In all they have nearly two hundred men at work and a large number of mules and horses in addition to the machinery they have in operation.

Details of the reconstruction, made necessary by the Wellington avalanche, show that for a considerable distance on the west slope of the Cascade divide the work is of the heaviest kind. The excavation and grading is planned for double track construction throughout the district. This means that for most of the 8 miles west from the tunnel to Scenic Hot Springs the road will be double tracked instead of single as now. This change will be of the greatest importance as affecting the rapid operation of trains west of the summit. For a mile west of the scene of the avalanche reinforced concrete snow sheds will be built over the tracks, making an impregnable and well nigh indestructible protection from ice and snow, falling rocks and trees which in times of forest fires cause temporary interruption to traffic. These snow sheds are the first ever built with roofs of steel and concrete. Approximately 400,000 cu. yds. of rock work is to be handled by the contractors. The

work will be completed by early winter. The cost of rebuilding the mountain road will be close to $1,200,000.

The immediate construction of the new branch of the Great Northern up Sun River Valley, Montana, now seems assured. The contractor's outfit has already been unloaded at Vaughn, and indications point to the early beginning of work. The assurance of transportation facilities for the Sun river irrigation project has renewed the interest of landseekers and the remaining farms on the Fort Shaw unit are being taken up rapidly.

The Sun river project occupies an area equal to that of Rhode Island. It contains some of the finest land in Montana and when fully developed will furnish homes for 50,000 people. Its canals will have a total length of 3,000 miles and the irrigation system will be one of the largest in the United States. The settlers express general satisfaction with the country, its climate, soil, and its future outlook.

The contract for the 16-mile extension of the Pacific & Idaho Northern Railway from its present terminus at Evergreen, north to Meadows, has been let to Maney Brothers & Company of Ogden. Work will begin as soon as the contractors can get their outfit on the ground.

The El Paso Southwestern is preparing in El Paso, at an expense of $10,000, a club house for its employes. The club rooms are in the building formerly occupied by the general offices.

Work on the Canadian Northern Railroad extension has been begun near Smithville, Minn. The right of way is being cleared, a large crew of men having been set to work. The contract for the road between Duluth and Virginia has been sublet in sections of from five to ten miles each. Foley, Welsh & Stewart are the general contractors, and E. M. Olson & Co., of Duluth, have been given the contract for the erection of section houses along the way. H. T. Hazen, chief engineer of the road, says that the preliminary work is progressing nicely. Mr. Hazen says the line will cost about $35,000 a mile. There will be 500 feet of rock tunnel at Short Line Park, according to the chief engineer.

Preparations are being rapidly made for the construction of the double track between Pueblo and Walsenburg, to be built by the Colorado & Southern and Denver & Rio Grande Railroads jointly. The Utah Construction Company, who hold contracts for the work, will open their offices at 101 North Union avenue, and the premilinary work of arranging for the shipment of gangs of laborers will be started. Work of making the grade will be started upon the arrival of five steam shovels, now on their way from Ogden, Utah. The work of construction will be rushed as quickly at possible so that the tracks may be ready for use during the coming winter.

The Baltimore & Ohio now has under construction some of the most extensive improvement work in its history. Improvements to meet the demands of the heavier traffic and equipment are being made throughout the system, including bridges, additional tracks and grade improvements between New York and Chicago and St. Louis. The rebuilding and strengthening of the bridge across the Schuylkill river, the reconstruction of many small bridges, and the Brandywine viaduct and Susquehanna river bridge, are some of the important jobs under way on the east end. The present Brandywine viaduct is to be replaced by a stone arch. The Susquehanna river bridge has recently been double tracked and strengthened, and a line change is now in progress at its west end. In Baltimore, grade crossings are being eliminated. East of Cumberland a third track will be built from Martinsburg to Orleans Road.

An important improvement is under way on what is known as the 17-mile grade between Piedmont and Altamont. At Altamont the grade reaches the highest point on the Baltimore & Ohio in the Alleghany mountains, and on this grade passing tracks are being installed. On the summit of the Alleghany mountains, between Deer Park and Mountain Lake Park, a continuous third track is under construction. Between Terra Alta and Grafton are heavy grades, which have to be climbed by all eastbound trains. A third track over this entire section to facilitate the handling of traffic and to relieve the two present main tracks will be added. In the section between Grafton and Terra Alta a new double-track tunnel, to replace the present Kingwood tunnel at Tunnelton, and a slight revision of the present line, about three miles east of the tunnel, will be constructed.

At the end of the Cumberland Division at Grafton, a new yard is being laid out to receive and classify coal and other traffic from the West Virginia and Pennsylvania coal fields.

Beginning again at Cumberland and going westward over the line to Pittsburg, a third track is being constructed between Philson and Manila, and Sand Patch and Yoder, at the west end of the Hyndman grade. Sand Patch tunnel is to be eliminated and a new doublt-track tunnel, 2.6 miles long, is to be built on a revised line. The revision of line extends westward to Meyersdale. Further westward on the line to Pittsburg a third track is to be built between Connellsville and McKeesport. At several points on the Cumberland Division tunnels are to be eliminated and made open cuts. The elimination of grade crossings is under way at many of the smaller towns on the system. West of the Ohio river a revision of grades is to be made on the Cleveland, Lorain & Wheeling Railroad, which is a heavy freight-carrying line to and from the lakes. The elimination of grade crossings in Columbus is a large piece of work, and on the Chicago Division, second track is being laid over the district between Wellsboro and McCools. At Lorain extensive improvements in the waterfront and docks and wharves are being made in order to handle the lake traffic, in Chicago track elevation and grade crossing elimination is in progress of construction.

It is announced that work on the construction of the Carolina, Clinchfield & Ohio will be resumed within a short time. When the work was suspended recently at Dante, Va., the line was within twenty-two miles of Elkhorn, Va. The road runs south to Spartansburg, S. C., and by a traffic arrangement with the Southern has an ocean outlet at Charleston, S. C., where the road is constructing a huge steel pier to cost about $2,000,000.

Work on the 500-foot tunnel near Shortline park, of the Duluth, Winnipeg & Pacific will soon be begun. In addition to the 500-foot cut there will be open cuts at each end. H. T. Hazen, chief engineer for the company, at Duluth, says that about 100 men will begin the work on the tunnel, and that the force will be increased from time to time, if the character of the work will permit. He says that camps are being established at various points along the line of construction. The grading on the road will be pushed as rapidly as possible this fall. Steel laying will be started this fall, from Duluth north. The estimated cost of the 500-foot tunnel is in the neighborhood of $100,000.

The Stuttgart & Rice Belt has awarded a contract to H. Dalhoff, Little Rock, Arkansas, for constructing its line, which is to run from Mesa on the Rock Island, 21 miles due south and one mile west to Stuttgart. This contract amounts to $250,000.

The contract has been awarded for clearing 10 miles of right of way for an extension of the Central Arkansas, Cypress & England to Stuttgart.

Construction work on the extension of the Pittsburg & Shawmut from near Knoxdale, Pa., to the Allegheny River, and thence to Freeport, about 65 miles, is progressing favorably. About two-thirds of the grading has been completed. The contract for 14,000,000 pounds of bridge steel has been awarded to the American Bridge Company, and erection work on the viaducts is under way. Along Mahoning Creek 36 miles represents very heavy construction, including four tunnels aggregating over a mile in length, and four high viaducts. The maximum grade on the entire line of the Pittsburg & Shawmut when completed from Hyde, Pa., to Freeport, a distance of 102 miles, will not exceed 0.6 per cent. At Hyde the road connects with the Pittsburg, Shawmut & Northern, with which it is to be merged as soon as completed, when the receivership of the latter road will be lifted. September, 1911, is set for the completion of the Pittsburg & Shawmut. Branch lines to the Tidal and Oakland coal fields, lying along Mahoning Creek, are also under contracts to be completed at the same time.

The immediate construction of the Denver & Gulf railroad from Texhoma to Lamar, Texas, is assured by the award of a contract to the Shumway Construction Company of New York for the building and equipment of fifty-five miles of railroad from Lamar south, the consideration being $1,000,000.

P. W. Ryan, of Janesville, Ill., has been awarded the contract for doing all the grading on the new Waukegan, Rockford & Elgin Electric road between Palatine and Wauconda. Work on the grading has begun and under the contract must be done by December 1.

—The Atlantic Coast Line is to build new freight yards at Bennettsville, S. C., to accommodate 1,500 cars.

—The Long Island has begun work on the terminal yard and station improvement at Jamaica, L. I., to cost more than $3,000,000. The station is to be ready by December. In connection with the improvements at Jamaica a new freight yard will be built at Richmond Hill.

—The Kansas City Terminal Ry., according to its report to the city of Kansas City, has already spent the sum of $12,587,845.09 on the proposed union passenger station and freight terminals. The complete statement follows:

Real estate	$ 7,570,594.32
Purchase of K. C. Belt Ry.	3,517,899.46
Grading	8,689.80
Track construction	1,906.89
Miscellaneous construction	1,230.10
Station buildings (plans)	55,673.35
Locomotives and equipment	298,310.23
Engineering	68,272.12
Law expenses	57,984.77
Taxes	62,562.97
Interest	758,065.81
Organization	102,509.89
Other general expenditures	84,145.38
Total	$12,587,845.09

—The New York, New Haven & Hartford and the city of Fall River, Mass., will build a bridge over the railroad tracks at that point. The road is also making surveys for a new double track bridge in Fall River to replace the present single-track structure and is planning to build a tunnel to connect the main line from Boston to Newport with a branch from New Bedford to Fall River.

The Signal Department

Railway Signal Standards No. 9. The Illinois Central

The Illinois Central installs automatic block signals of the top post mechanism, two arm, home and distant, lower quadrant, two position type. Signals stand normally clear and the stroke of the arm is 60°. Night color indications are, green for clear, yellow for caution, red for stop. Signals are operated by electric motors. The distance from top of foundation to middle of upper arm is 31 feet 6 inches and arms are spaced 6 feet apart. The top of the foundation is 1 inch below the top of rail. The foundation and layout of apparatus at a signal is shown in Fig. 215.

Signal operating battery is of the potash primary type, housed in concrete wells or storage in wooden boxes. The same battery is used for line control circuits. A storage battery case is shown in Fig 216. Storage battery is charged from line circuits fed from a power house by a gasolene engine driven generator or a mercury arc rectifier. Portable storage battery is also used. These storage batteries are charged at a central charging station equipped with gasolene engine. Maintainers bring their exhausted batteries to the station in cells and return with a duplicate that has already been charged. This station is in charge of one man who charges the batteries, overhauls and repairs them and does other repair work on signal mechanisms, relays, coils, etc.

Typical rectifier circuits are shown in Fig. 217 and a manipulation chart in Fig. 218. Below are the standard instructions for handling rectifiers:

"To start rectifier: Close the circuit breaker, also the A. C. switch. Hold the starting switch in the lower position and rock the bulb gently by means of the handwheel connected to the holder.

"This will cause a mercury bridge to be formed and broken between the starting anode 'S' and the cathode 'R.' This in turn will cause a slight flash and the rectifier will start. Under ordinary conditions, a single flash should be sufficient to start the bulb; but in cold weather, or when a bulb is run at lower than rated voltage more than one shake may be necessary. In cold weather hold the spring switch in lower or starting position for at least 30 seconds, so the bulb will be somewhat warmed before full load is thrown on. When the hand is removed from the spring switch it will automatically throw into the upper position and transfer the rectified current from the starting resistance to the load, and will also open the starting anode circuit.

"If the load be a battery and its voltage be higher than that of the rectifier, the bulb will go out when the spring switch moves to the load position. If such is the case, the voltage of the rectifier should be raised by means of the regulation switch, which should be moved down or counter clockwise, and the bulb restarted. In case this does not give the desired current the voltage should be further increased by means of the rough regulation switch, which should be moved up (counter clockwise) a button or a sufficient number, until the desired current and voltage is obtained. After once determining the position of the rough regulation switch, most of the regulation can be obtained by means of the fine regulation switch.

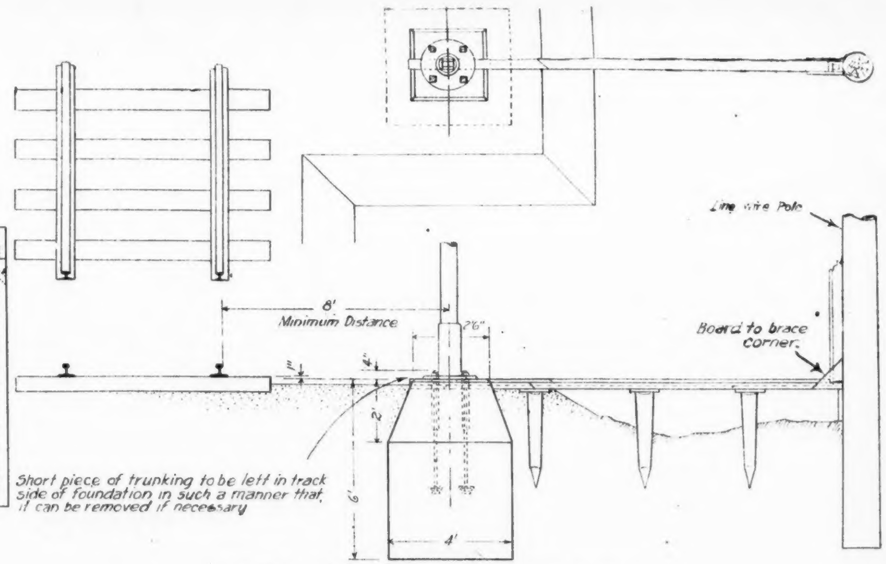


Fig. 215. Signal Foundation. Illinois Central.

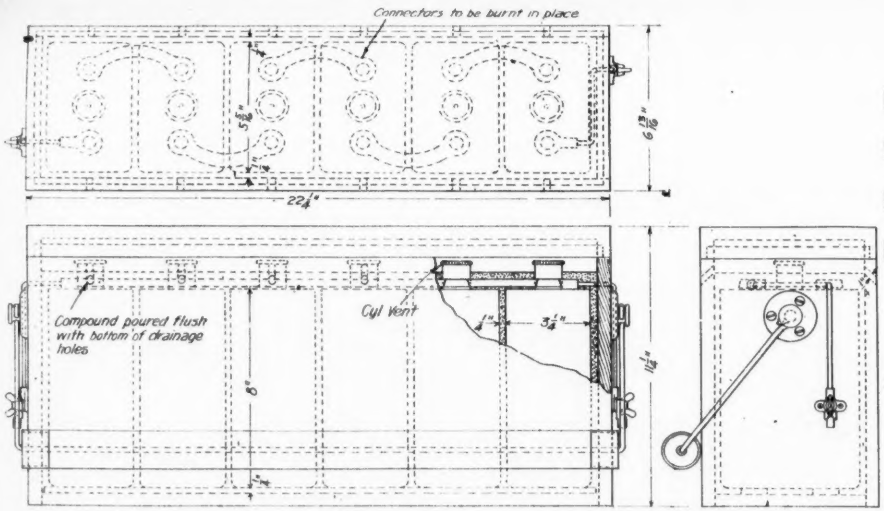


Fig. 216. Storage Battery Case. Illinois Central.

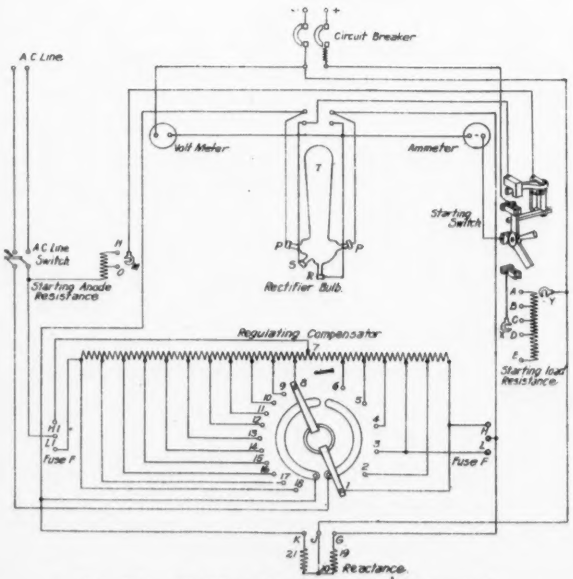


Fig. 217. Rectifier Circuits. Illinois Central.

Connect G to 19, J to 20, K to 21.
110 Volts A.C.
Connect M to O on Starting Anode Resistance.

D.C. Volts	Position of Fuses F.	Position on Rough Regulating Dial.	Connections of Starting Load Resistance.	
5 to 15	L - L1	1	Y to A	X to B
10 " 22	L - L1	2	Y " B	X " C
15 " 32	L - L1	3 or 4	Y " A	X " C
20 " 40	L - L1	5 " 6	Y " C	X " E
30 " 44	H - H1	1	Y " C	X " D
42 " 59	H - H1	2	Y " B	X " D
54 " 74	H - H1	3	Y " A	X " D
66 " 115	H - H1	4, 5 or 6	Y " D	X " E

220 Volts A.C.
Connect M to N on Starting Anode Resistance.

D.C. Volts	Position of Fuses F.	Position on Rough Regulating Dial.	Connections of Starting Load Resistance.	
30 to 64	L - L1	1 or 2	Y to B	X to D
47 " 85	L - L1	3 " 4	Y " A	X " D
60 " 100	L - L1	5 " 6	Y " D	X " E
87 " 117	H - H1	1	Y " D	X " E
110 " 148	H - H1	2	Y " C	X " E
135 " 179	H - H1	3	Y " A	X " E

Fig. 218. Rectifier Manipulation. Illinois Central.

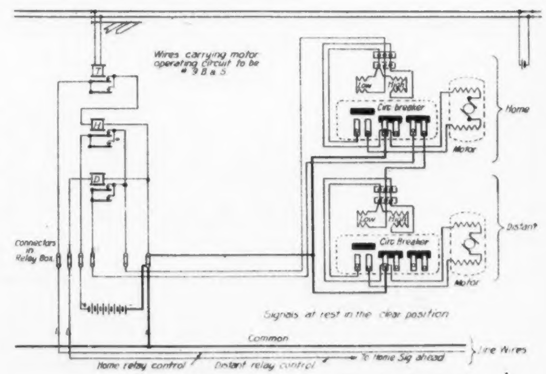


Fig. 220. Signal Wiring. Illinois Central.

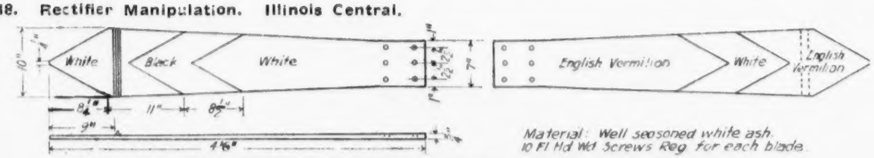


Fig. 219. Home Signal Blade. Illinois Central.

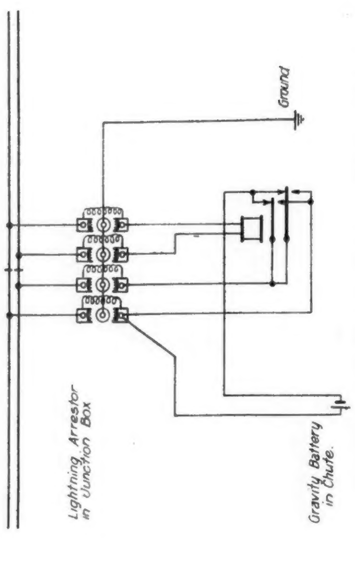


Fig. 223. Cut Section Wiring. Illinois Central.

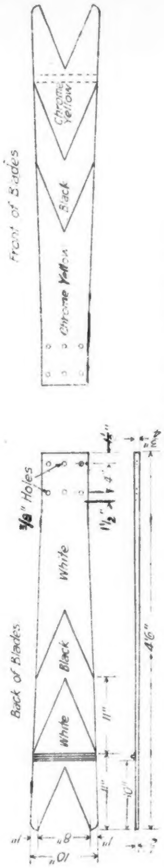


Fig. 220. Distant Signal Blade. Illinois Central.

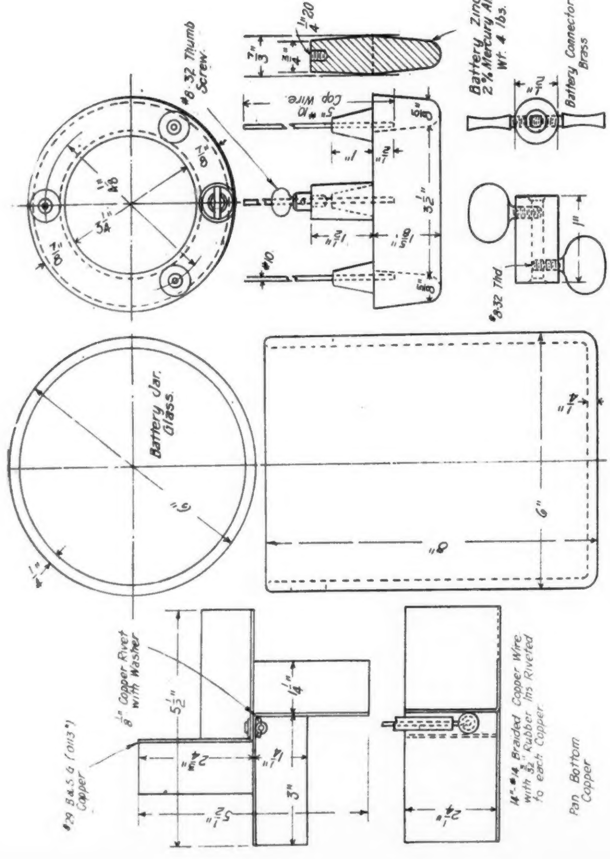


Fig. 221. Gravity Battery Details. Illinois Central.

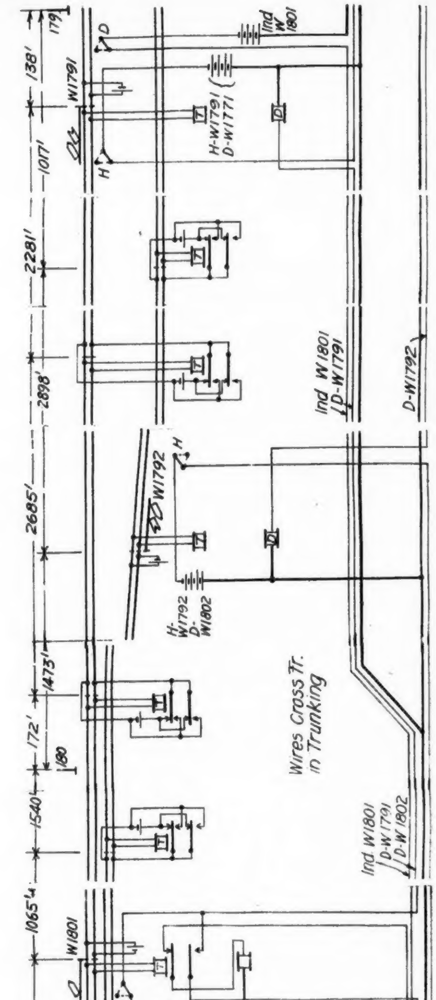


Fig. 225. Automatic Block Signal and Indicator Circuit. Illinois Central.

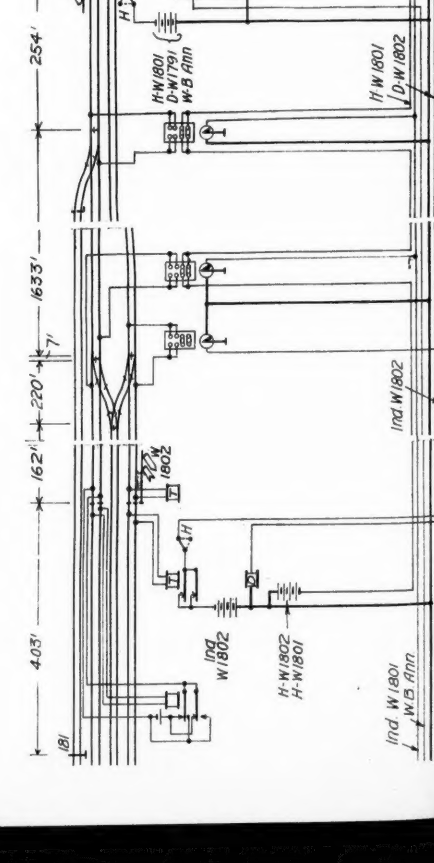
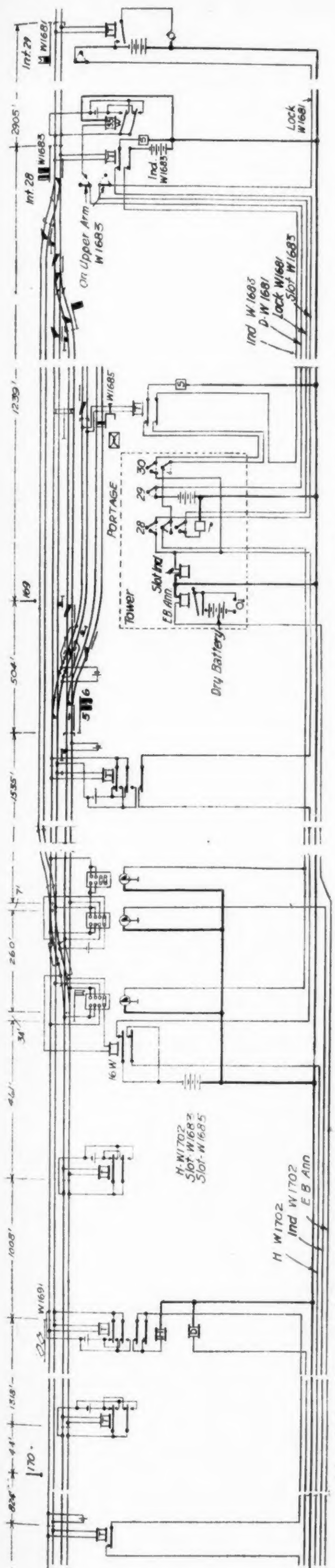


Fig. 224. Automatic Block Signal and Indicator Circuits. Illinois Central.

Fig. 224. Automatic Block Signal and Indicator Circuits. Illinois Central.

Fig. 225. Automatic Block Signal and Indicator Circuit. Illinois Central.



Figs. 227, 228. Special Circuits. Illinois Central.

Fig. 226. Special Circuits. Illinois Central.

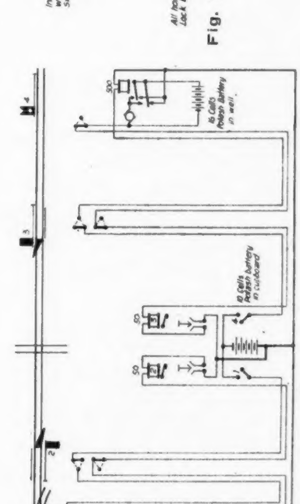


Fig. 229. Power Distant Signal Circuits. Illinois Central.

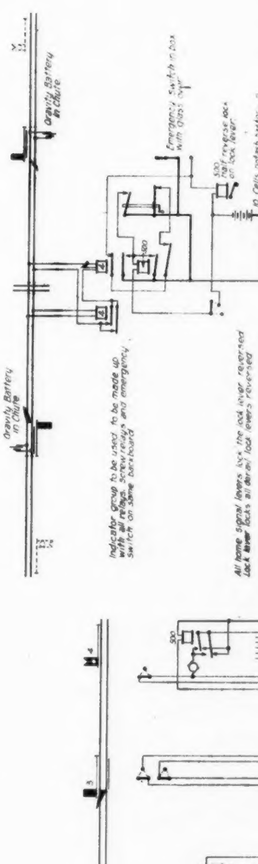


Fig. 230. Route and Detector Locking Circuit. Illinois Central.

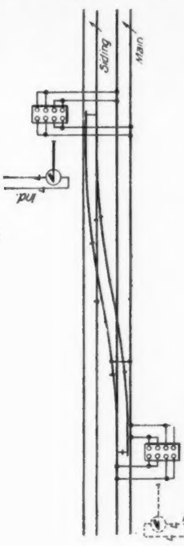


Fig. 231. Track Circuit Through Siding Crossover. Illinois Central.

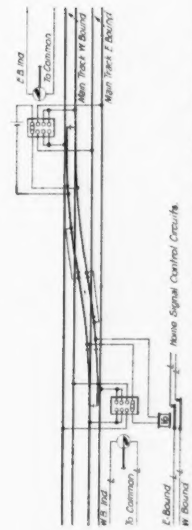


Fig. 232. Track Circuit Through Main Line Crossover. Illinois Central.

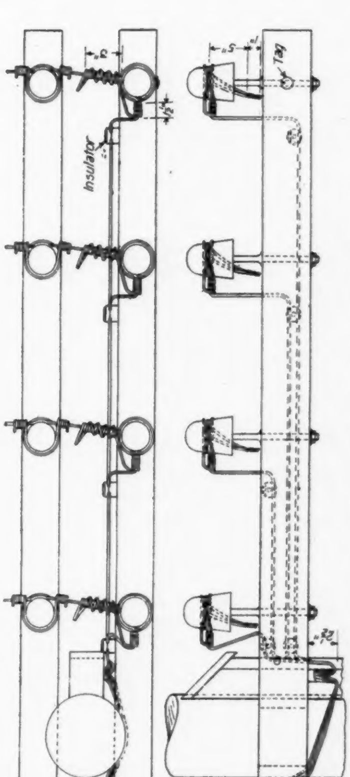


Fig. 234. Connection from Line to Leads. Illinois Central.

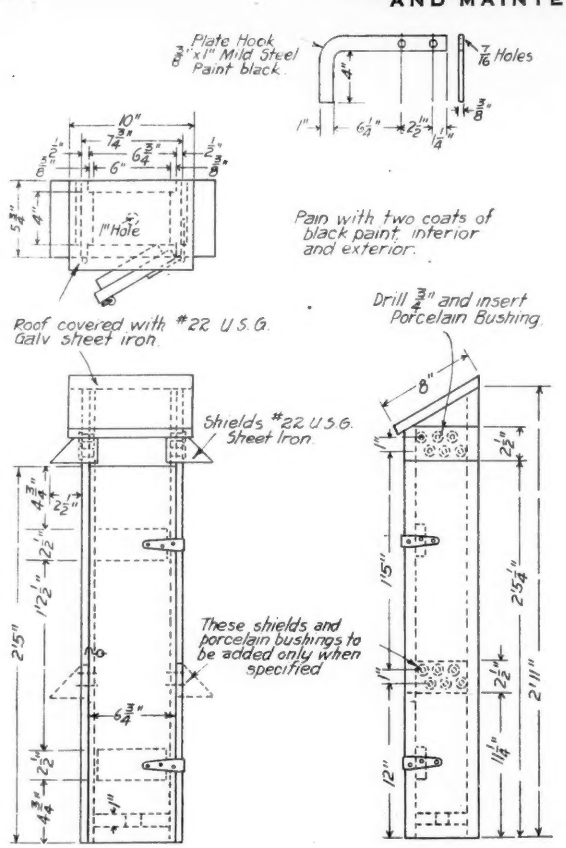


Fig. 236. Cable Box. Illinois Central.

"Remember

"That the bulb should be handled carefully.

"That the setting of the circuit breaker should not exceed the rated ampere capacity of the bulb.

"That the instructions should be read carefully before attempting to operate panel.

"That the bulb should never be used above its rated voltage and rated ampere capacity."

The spectacle is similar to that shown in Fig. 149. The blades are shown in Figs. 219, 220.

Track battery consists of two cells of gravity battery housed in cast iron crates similar to that shown in Fig. 47. Gravity battery details are shown in Fig. 221.

Signals are connected up as shown in Fig. 222, and relay cut sections as in Fig. 223. Figs. 224, 225 are continuous with each other and show typical automatic block signal and envitar indicator circuits. Special circuits to meet local conditions, interlocking, etc., are shown in Figs. 226, 227, 228. These include circuits for slatted mechanical signs. Circuits for the control of a power operated distant signal at a mechanical interlocking plant are shown in Fig. 229. Fig. 230 illustrates circuits for route and detector locking at a simple crossing. Note that a route or key lever is used on which the lock acts.

How track circuits are handled at a siding crossover is shown in Fig. 231, at a main line crossover, in Fig. 232. A simple turnout is handled substantially as shown in Fig. 40. Indicators of the lower quadrant semaphore or bell type are used at all switches. The semaphore type is standard.

Wire ducts are of wooden trunking above ground where possible. Conduit is used in houses and under street crossings. The wooden bootlegs are shown in Fig. 233.

A separate pole line is used to carry block signal circuits. Standard connection from line wire to leads is shown in Fig. 234, and from line to cable with a cable box in Fig. 235. The cable box is shown in Fig. 236. The common wire is continuous throughout. Lightning arrester boxes are mounted on poles as in Fig. 237. The standard ground is a spiral of copper wire, Fig. 238.

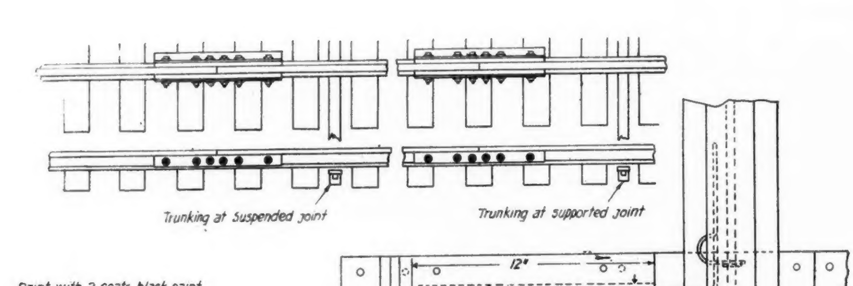


Fig. 233. Wooden Bootleg. Illinois Central.

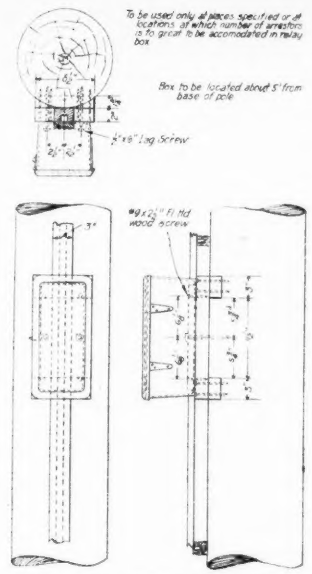


Fig. 237. Lightning Arrester Box. Illinois Central.

Track relays are of 4 ohms resistance and meet the R. S. H. Specifications.

The following sizes and types of wire are standard: for bootlegs, leads from line to apparatus and between battery and mechanism No. 9, B. & S. gage, rubber covered solid copper wire; in chutes, No. 9, B. & S. gage rubber covered, stranded copper; for line, various types and sizes are used.

—The Rock Island expects to install a. c. automatic, three-position, upper-quadrant block signals between Gresham and Stoney Island avenue (Chicago). This line is used jointly by the Rock Island and B. & O. and, until the Grand Crossing elevation is completed, by the Nickle Plate and Lake Shore.

Secretary C. C. Rosenberg announces that on the occasion of the annual meeting at Richmond, Va., October 11, 12 and 13, the headquarters of the association will be at the Hotel Jefferson. The prices for rooms (European plan) vary from $1.50 a day for one person in a single room overlooking the court, to $5 for two persons in a double room, with bath, on the main front of the hotel.

COLLISIONS IN EUROPE

On August 14 a rear end collision occurred at Saujon, France, in which thirty-seven persons were killed and a large number injured. An excursion train from Bordeaux, carrying several hundred passengers, ran at high speed into the rear of a freight train. Several of the passenger cars were completely crushed. Many of the victims were school girls. According to one account, the collision was due to a misplaced switch.

The Chicago, Milwaukee & St. Paul has now 26 miles of automatic block signals between Morton Grove and Rondout on the Chicago and Milwaukee division. The blocks average one mile in length. Upper quadrant Union Style "S" signals were installed, and Model "2-A" top-post mechanisms, made for purely automatic purposes by the General Railway Signal Co., were put in at the interlocking plants. This road has recently changed its lower quadrant signals between Chicago and Franklin Park, and between Chicago and Morton Grove, to upper quadrant.

The Pittsburg & Lake Erie is planning to install automatic block signals on double track between Roscoe and Brownsville, Pa., on the Monongahela division. There will be about 17 two-arm home and distant lower quadrant signals.

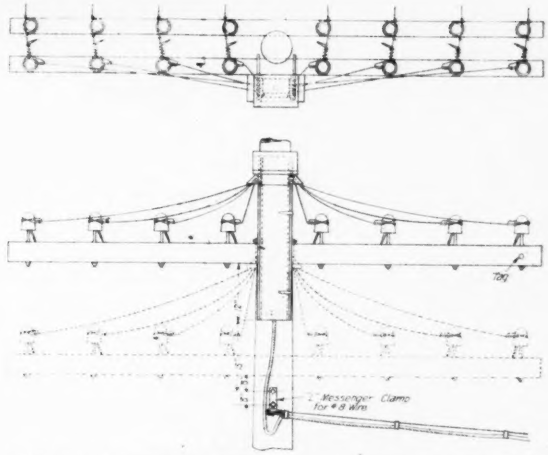


Fig. 235. Connection from Line to Cable with Cable Box. Illinois Central.

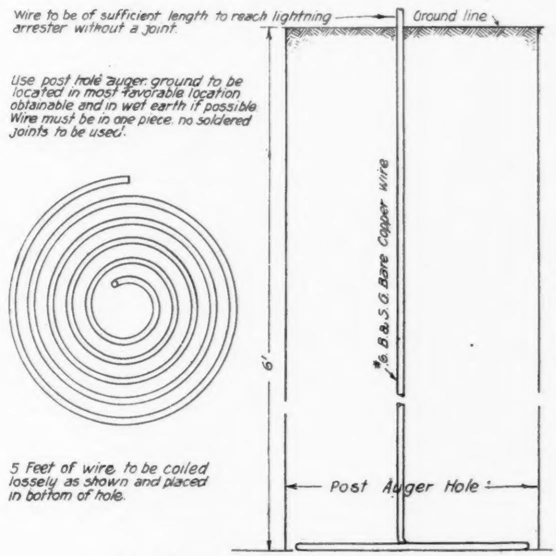


Fig. 238. Ground Connection. Illinois Central.

A disastrous derailment occurred in Russia, July 31, and a collision in Ireland on the 19th. The derailment was at Kisilarwat, on the Transcaspian Railway, killing nineteen and injuring thirty-one. The collision was on the Great Southern Railway, at Roscrea, in the northwestern part of Tipperary County. An excursion train broke away from the locomotive and ran back down a grade into the head of a following passenger train—an accident apparently quite similar to that at Armagh, Ireland, in 1889, when eighty passengers were killed and 262 injured. In the present case 100 passengers were injured, but most of the injuries were slight. Many persons jumped from the runaway cars and tumbled down a bank. At Winnipeg, Man., July 8, a locomotive ran into a street car on a crossing, killing three persons and injuring many. The engineman said that the flagman had given him the signal to go ahead, and the flagman was arrested.

The first train was recently sent through the new tunnel under the Detroit river at Detroit, Mich.

The Grand Trunk Pacific last month began running a train regularly to and from Edson, Alberta, 146 miles west of Edmonton, which has been the terminus for the past year. From coal mines on the Brazeau river, south of Edson, the company expects to get 5,000 tons of coal daily.

Second Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission

(Continued)

The dispatcher never orders a train to proceed farther than to the next station (instead of issuing orders relating perhaps to a half dozen meeting points), and thus the making of his orders is greatly simplified. He has to issue a much larger number of orders, yet his work takes less time than under the old system. The time-consuming features of the old system are necessary because of the danger of mistake on the part of conductors and enginemen. This danger is guarded against in the new system by the simplification of orders and by requiring every train to get an order at every station, stopping and asking for one if it is not offered. This insures regular habits in this respect on the part of all trainmen. The practice of giving new orders at every station, good only to the next station, converts this dispatching system into a block system, and no time-table is used or needed (except such as may be necessary for the convenience of station agents and the information of passengers). The system, as a system, is thus a decided improvement over the ordinary "time-table and dispatcher" system.

It might be asked, why make this innovation instead of adopting the simple telegraph block system, long in general use? The reply is that that system has not been deemed a sufficient means—has not been used to any considerable extent—to safeguard trains against opposing trains on single track without having also the time-table and the old dispatcher system, with their time-consuming features, in use as a co-ordinate safety system.

As compared with the telegraph block system (using the telegraph block system without a time-table) the main improvement under the A B C regulations is the requirement that every engineman shall ask for an order ("card") at every station. This promotes accuracy and vigilance on the part of the station telegrapher as well as on that of the engineman, and, with it, the Northern Pacific trusts the telegraph block system.

In considering the A B C system it is proper, also, to compare it with the electric train staff system, which is classed as a "controlled manual" block system. In this comparison the A B C system has no important advantage, except in cost of apparatus, and it has the theoretical disadvantage that the electric train staff apparatus, designed to prevent any possible error on the part of the station signalmen and any possible evil consequences from an error on the part of the dispatcher, is quite simple and is subject to few derangements; whereas the human instruments of the A B C system may err, and this from causes which have usually been held to be largely beyond control.

With automatic block signals, also, the comparison would be, first, one based on cost of apparatus. In cost alone the difference between the two systems is so great that for the present we may say that a comparison need not be considered.

The Northern Pacific has found that with the A B C system its heavy freight trains are run over the road in 20 per cent less time than under the old system, where all train orders had to be in the form of telegrams to conductors, and had to be repeated and signed for. This economy is important to the company and an advantage to the public; and it has enabled the trainmen to earn their regular mileage pay in fewer hours than formerly; but, of course, economy must not be sought at the expense of safety. It may be admitted freely that the A B C system is theoretically a simpler means for safe-guarding opposing train movements on single track, and therefore a safer means, than the time-table and the dispatcher system; and even that it is practically so, in so far as may be judged by the experience thus far had with it; but in the safeguarding of railroad trains, which means the care of many lives, the only acceptable standard for comparison is the highest attainable perfection.

The weakest feature of the A B C system—aside from questions of personnel and discipline—is that the "duplicate order" principle is not used. Under this principle an order affecting two opposing trains is written in the same words for both trains. For example; "To train No. 1: Trains 1 and 12 will meet at Millville; No. 12 take siding." "To train No. 12: Trains 1 and 12 will meet at Millville; No. 12 take siding." Under the A B C rules the dispatcher issues orders in form like the following: "To train No. 1: * * * take siding for No. 12 at Millville." "To train No. 12: * * * hold main track and meet No. 1 at Millville." If by mistake he tells both trains to hold main track, the safeguard against a collision at the meeting point is only the thickness of the signal post at the station, as each train would have the right to proceed to (but not beyond) the signal. Two collisions have occurred on the Northern Pacific at meeting points. In both cases the dispatcher by mistake directed both of the trains to continue along the main track, and the station operators did not discover and correct his error. Both of the station operators interested should have seen the dispatcher's error, for each of them, after hearing his order, had to send a similar one, and to compare it with the dispatcher's. In one of the cases one of the trains ran past the stop signal at the station, which was midway between the ends of the passing track. This disregard of a stop signal is a kind of negligence that may occur under all block systems unless they have derails or automatic stops to forcibly halt the train. In the other case the meeting point was a "blind siding" —that is, a passing track between two stations—with no station agent or telegrapher. After the occurrence of these collisions the Northern Pacific adopted a rule under which at meeting points the train holding the main track, as well as the one which is to enter the siding, must stop at the approach to the station; that is, before reaching the first switch. This seems satisfactory safety provision, than to adopt the "duplicate" to have been deemed less wasteful of time, as well as a more method of wording the meeting orders. And this rule prevails not only at "blind sidings" but at telegraph stations as well. This rule, nearly or quite equivalent to a rule requiring all trains to be run with speed under control at every point within yard limits, and not merely under that degree of control necessary to make a stop at the station signal, is, no doubt, adequate *so far as a rule can be adequate,* to cure the weakness which has developed; but, obviously, the strength of any rule for the conduct of trainmen lies in its enforcement; and the question whether the A B C system approximates perfection in a reasonable degree can be answered only after considering carefully the methods of discipline which are carried out to guard against errors, neglect, or misconduct.

It is to be borne in mind that any arrangement by which trains meet at a siding where there is no attendant and no signals is hardly to be considered as a legitimate part of a block system. The practice of the Northern Pacific in giving work trains the right to the use of a block section for a certain number of hours is also a questionable modification of the block system principle. It is true that with this the dispatcher, in his orders designed to keep other trains out of that block, may omit mention of the time limit, requiring such other trains to keep out indefinitely; but the fact that time limits are countenanced for any purpose makes more difficult the task of uniformly enforcing the true space-interval principle, which must not depend on time.

Where trains have to be divided between stations, and in all such irregular conditions, the A B C system has the same disadvantages as most other systems.

In the case of a long-continued failure of the telegraph or telephone line, a temporary time-table would have to be used. Such a time-table is printed and kept in readiness.

It is fair to express the purpose of the A B C system as being to make the telegraph block system safe enough to justify the abandonment of the time-consuming safeguards of the old sys-

tem. These safeguards are the time-table, with its rules, and the written-and-repeated dispatcher's order. A main feature of the A B C system is the reuirement that no train shall pass any station until it has received a "card." This requirement means that every train must approach every station prepared to stop. Distant signals, situated 100 rods or more from the station, to enable the station man to give the engineman seasonable notice that he will be required to stop, are provided at only a part of the stations on the Northern Pacific. Where such signals are not provided the strictest discipline is necessary to secure regular obedience to the rule to be prepared to stop, as has just been observed.

In addition to this feature of discipline the discipline of the dispatchers and the station signalmen—working by means of the telegraph or the telephone—must be an important element.

Concerning these matters of discipline the board has not yet been able fully to inform itself, and therefore does not attempt to formulate a precise estimate of the absolute or the comparative merit of the A B C system; but in view of its extended use on the Northern Pacific lines, its time-saving features, and its elements of simplicity, it has been deemed proper to give this account of it.

CONTROLLED MANUAL SIGNALING.

The board has made no detailed inspection of the controlled manual block-signal system during the year. Considering only those installations in which track-circuit protection is employed —which are found principally on two roads, the New York Central and the New York, New Haven & Hartford—it is to be observed that both of these roads are now taking some of these signals out of service and putting up automatic signals in place of them. The New Haven road is making this change in connection with the reconstruction of its line from New Rochelle to Harlem River, N. Y., 12 miles, which has been made a six-track line. The New York Central is making it on its main line between New York City and Buffalo. Several sections, aggregating about 50 miles of line, have been changed already, and it appears to be the intention to supersede the manual by the automatic on the whole of the 440 miles between the cities named, the larger part of which is four-track line. The chief reason for making the change is to increase the capacity of the road by making the block sections very much shorter than heretofore. To do this with manual signals would increase the annual cost by the amount of the wages of the three signalmen required at every new block station; whereas with automatic signals, requiring no attendants to operate them, the cost of operation is slightly increased by increasing the number of blocks.

The use of controlled manual on three important single-track railroads was briefly referred to in our last annual report. One of these roads, the Illinois Central, discontinued the use of its controlled manual block system early in 1908 because of the falling off in business and of the increase in cost of wages of signalmen due to the requirements of the hours-of-labor law, under which block-signal offices kept open twenty-four hours a day must have three signalmen, the men working eight hours each daily. This plan increased the expenses for wages nearly or quite 50 per cent, the former plan having been to work such offices with two men, each being on duty twelve hours a day. These lines, aggregating about 780 miles in length, are now worked under the "time table and train dispatcher" system.

The most complete installation of the controlled manual block system (other than the train-staff system) which is known to the board as being in use on a single-track line where operations are carried on under ordinary single-track conditions is that on the Pennsylvania Railroad between Cameron, Pa., and Sterling Run, a distance of 3½ miles. These signals have been in use three years, and have given satisfactory service.

THE AUTOMATIC BLOCK SYSTEM.

New automatic signals have been erected and put in service by a number of railroads during the past year, aggregating a considerable mileage. The exact figures have not yet been compiled. The three-position upper-quadrant semaphore is used in a large part of these new installations, this design having found favor with the majority of signal engineers. With signal arms moving upward from the horizontal or stop to the vertical or clear position, there is greater security against accidental sticking of a signal wrongfully in the clear or "proceed" position, as gravity tends constantly to move the arm to the stop position, and any accumulation of ice or snow on the arm helps this tendency instead of tending to counteract it, as may be the case with arms moving in the lower quadrant. This design of semaphore is more economical as well as safer, as the three indications of a single arm (and a single lamp at night) serve all of the purposes of two separate arms and lamps in the usual two-position arrangement.

A notable installation of automatic block signals completed during the past year is that of the Hudson & Manhattan Railroad between Church street, New York City, and the Pennsylvania Railroad station in Jersey City. This line is in tunnels beneath the Hudson River, and at the busiest hours of the day the number of trains is such as to demand that the tracks be used to the limit of their capacity. As in other tunnel-signal systems in and near New York, the "overlap" is used to guard against collisions from inattention to signals on the part of the motorman, and with every block section there is an automatic stop, designed to apply the brakes even if the motor man be wholly oblivious to his duties. These safeguards being provided and the block section being made very short, trains are run with safety at 50 miles an hour, following one another at intervals of one minute and a half. On this line all of the electrical apparatus is worked by alternating current and a number of new designs of apparatus are made use of.

Both the Hudson & Manhattan (on the new line here mentioned and on its older line) and the Interborough Rapid Transit Company, of New York, referred to in our last report, have all of their high-speed tracks equipped with automatic train stops (mechanical trips); and officers of both companies state that these trips have never failed to stop a train which passed them wrongfully; that is, the apparatus has never failed to perform its duty as a safety device. On the Interborough these stops have now been worked (in unison with signal movements) many million times.

(To be continued)

The annual convention of the American Society of Engineering Contractors will be held in St. Louis, Mo., September 27-29, with headquarters at the Coliseum. Papers will be presented as follows: "Dam Construction for City Water Supplies," by J. M. Goldsboro and E. Wegmann, both of New York City, and "Work Preliminary to Street Paving and Road Work," by George C. Warren, Boston, Mass. A banquet will be held and several sightseeing trips will be made to important engineering works in and around St. Louis.

L. B. Allen, engineer maintenance of way on the Kentucky general division of the Chesapeake & Ohio at Richmond, Va., at Covington, Ky., has had his jurisdiction extended over the Chesapeake & Ohio of Indiana.

H. M. Taylor has been appointed director of construction of the Pan-American Railroad.

F. H. Alfred, assistant to the president, in charge of the engineering department of the Cincinnati, Hamilton & Dayton, at Cincinnati, Ohio, has been appointed general superintendent, with office at Cincinnati.

FARMERS' INSTRUCTION TRAINS ON THE PENNSYLVANIA

Beginning August 22 and continuing until September 7, the Pennsylvania Lines operated a farmers' special instruction train through Indiana. The object was to give Indiana farmers an opportunity to hear lectures on methods for improving wheat by experts from the Purdue experiment station. These talks treated of selection of varieties of wheat, cultural methods, control of plant diseases, and methods of combating injurious insects. This fifteen days' tour was a continuation of the campaign started by the Pennsylvania to improve the mthods of farming in the states through which it operates. Since 1907 a number of speciai instruction trains have been operated in Ohio, Indiana, New Jersey, Pennsylvania and Maryland, and farmers' educational steamboats have been run on the rivers tributary to Chesapeake bay by the Maryland, Delaware & Virginia and the Baltimore, Chesapeake & Atlantic, subsidiary lines of the Pennsylvania. This last train consisted of an engine, two coaches fitted up as audience rooms, and a car for those accompanying it. The train started from Logansport, Ind., and during the fifteen days stopped at some 156 stations on the Vandalia, the G. R. & I. and the Pennsylvania Lines. At each of these stations two 30-minute lectures were delivered in the coaches.

Simultaneously with the running of the "Wheat Improvement Special Train" through Indiana, another farmers' instruction train was operated through Ohio on August 22, 23 and 24. This train consisted of an engine and three lecture cars. At each of the twenty-five stops three 20-minute lectures were given, the lecturers going from one car to the other, as each car was equipped with charts and diagrams for the specific lecture to be given in that car. One car was assigned to talks on seed preparation, selection, etc.; another to the subject of fertilization, and the third to varieties, cultivation and diseases of wheat. This train was in charge of A. B. Graham, superintendent of agricultural extension, Collge of Agriculture, Columbus, Ohio.

The instructors included director Charles E. Thorne, C. G. Williams (agronomist), and F. A. Welton of the State Experimental Station at Wooster, Ohio; Professors A. G. McCall, E. D. Waid, H. C. Ramsower, W. H. Darst and Firman E. Bear of the College of Agriculture, Columbus, Ohio. There were also reprsentatives of the railroad on the train. Persons desiring to hear a lecture that was not given at one point were given an opportunity to accompany the trains to the next stopping place, or as far as they desired to go, on payment of the regular fare. Abstracts of all lectures were distributed at each station to all interested.

The Ohio Farmers' Special Instruction train stopped at the following points: East Palestine, New Waterford, Columbiana, Garfield, Beloit, Alliance, Louisville, Massillon, Lawrence, Orrville, Smithville, Shreve, Big Prairie, Lakeville, Loudonville, Perrysville, Lucas, Bucyrus, Nevada, Upper Sandusky, Forest, Dunkirk, Ada, Lima and Middlepoint. Night sessions were held at Orrville and Bucyrus on the 22d and 23d, respectively.

INTERNATIONAL RAILWAY CONGRESS

The next meeting of the International Railway Congress will be held in Berlin, Germany, in 1915.

With the Manufacturers

ELECTRO-MECHANICAL MACHINE.

The Union Switch & Signal Co. makes two types of electromechanic interlocking machinery. One, "Style P," is made under the Post patents, and is described as follows:

It is becoming customary to install power operated home signals at mechanical plants and to equip these plants with electric locking. This necessitates a lever more suitable for operating the signals than an ordinary mechanical lever, a more direct electrical control of mechanical levers and more reliable circuit controllers. The electro-mechanical interlocking machine was designed to meet these conditions. It consists of miniature levers for the control of power operated signals, and all electric block and circuit controllers are directly connected to these miniature levers and standard mechanical levers for the operation of switches.

There is a row of mechanical levers and placed above them another row of miniature levers similar to those used in power interlocking, so arranged that each mechanical switch lever has its electric controlling lever directly above it. The signal operating levers are placed between the switch controlling levers.

Each switch lever has a heavy mechanical lock between it and its electric controlling lever, so arranged that the controlling lever must be thrown to its middle position before the switch lever will be released. After the switch lever has been thrown and latched, and the switch is locked in its corresponding position, the stroke of the miniature lever can be completed, and this in turn will lock the mechanical lever. The lock consists of a horizontal rod connected to the rocking link on the mechanical lever. It has notches cut in it so that it is securely locked by a vertical rod connected to the miniature lever.

All machine locking between levers in accomplished in a small locking bed, with miniature rods connected to the controlling levers, thus eliminating the large locking frame and heavy rods of the purely mechanical machine. The liability of straining or forcing the machine locking is reduced to a minimum by this transferring the locking from the mechanical levers, to the miniature levers. This feature has the additional advantage of affording a more direct connection between the locking rods and their operating levers which reduces the possibility of lost motion.

The electro-mechanical machine is very compact. It needs only approximately one-quarter of the space ordinarily occupied by a mechanical interlocking machine and requires the same space as a power machine operating an equal number of switches and signals.

Switches are operated and locked by switch and lock movements, with the same reliable results as in power interlocking. This is due to the use of similar electric locks and indication circuits connected to the switch controlling the electric levers, and this arrangement eliminates the need of facing point locks and the levers and pipe lines required for their operation.

Track circuit detector locking is used instead of detector bars. An electric lock is provided on the miniature switch controlling lever, this lock being so arranged that when a train is on any switches involved a movement of the switch throwing lever is prevented. Typical circuits used are shown in Fig. 1, which also shows the method of locking between the two types of levers.

In this type of machine the electric levers are spaced 2 1-2 in. center to center and the mechanical levers 5 in. apart. The electric levers point alternately up and down, the former being switch and the latter signal levers. Each electric switch lever stands directly over its corresponding mechanical switch lever and bears the same number. The locking bed is carried by the electric machine, the mechanical levers being bolt-locked by their respective electric levers only. All switch levers carry odd, and all signal levers even numbers.

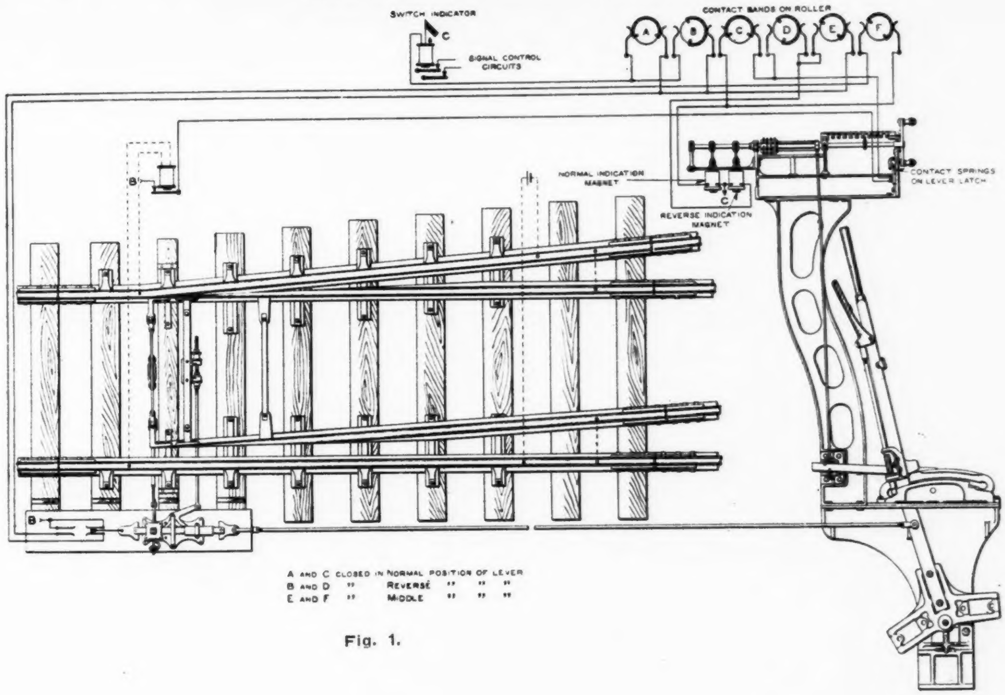
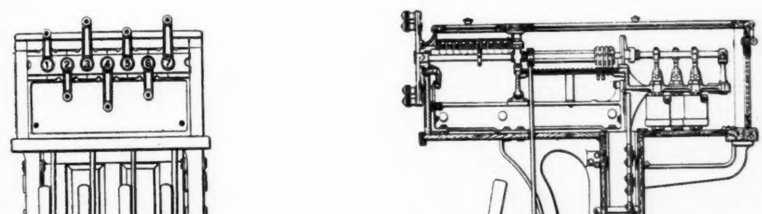


Fig. 1.



Front View Side View

Fig. 2.

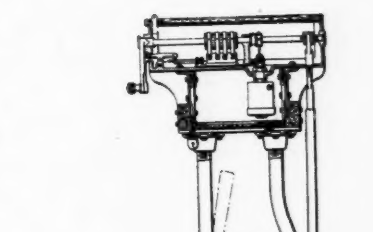


Fig. 4.

These machines are made in the following sizes and combinations: A, style "P" machine, with four mechanical and seven electric levers; B, as above, with eight mechanical and fifteen electric levers; C, as above, with twelve mechanical and twenty-three electric levers; D, as above, with twenty-four mechanical and forty-seven electric levers. The machine is illustratd in Fig. 2.

The second type of machine is known as the Style "S" and

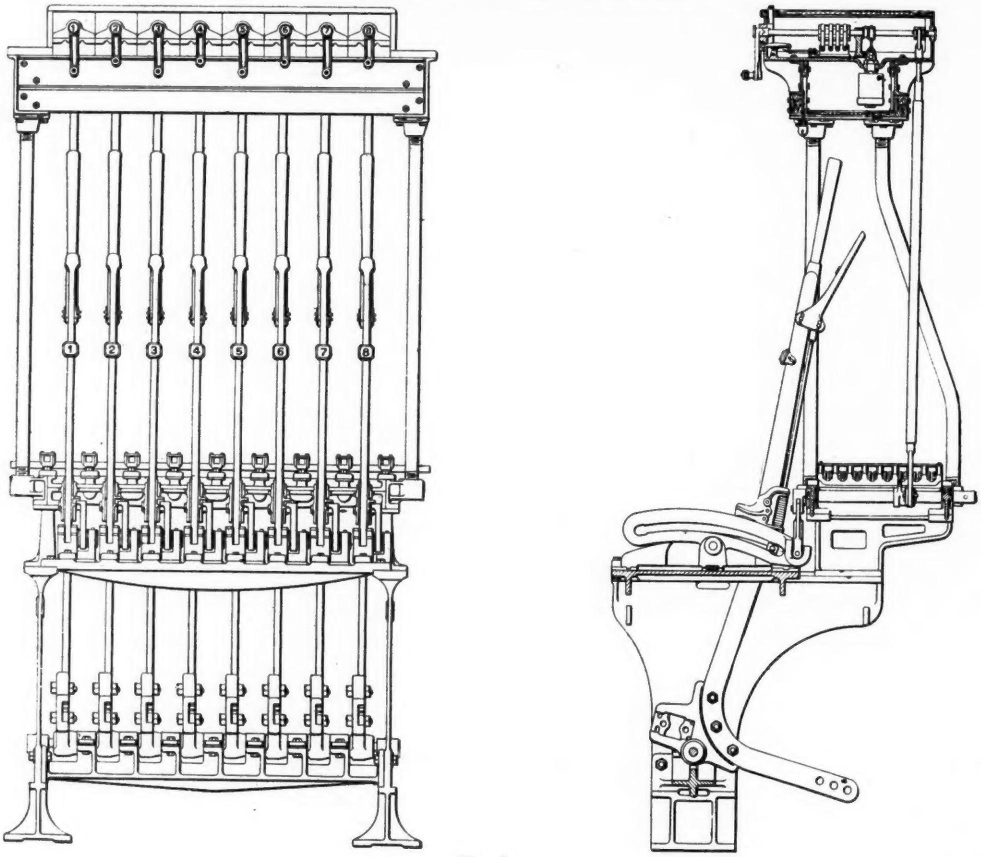


Fig. 3.

is thus described: Until recently, as above stated, power signals have been operated by circuit controllers combined with electric locks attached to mechanical levers. This arrangement, while fairly satisfactory, is distinctly inferior to the use of separate levers of the type employed in power interlocking machines, both because of the greater stresses on the electric locking devices and the greater room taken up by the mechanical levers. The electric levers, while principally intended for the control of signals as described, can also be used for other purposes, such as electric locking between adjoining towers and between towers and outlying switches, direction control of traffic, etc.

The construction of this machine can be readily seen from Figs. 2 and 4. The electric levers are separate units spaced 5 in. between centers on horizontal beams carried by pipe supports attached to the locking bed of the mechanical machine. The wires leading to the electric levers can be run inside the pipe supports, and thence in horizontal conduit to the levers. From cranks on the shafts of the electric levers, vertical rods connect to rack and pinion drivers for operating the locking bars in the bed of the mechanical machine, these drivers being free to turn on the locking shafts of mechanical levers. In this way any desired locking can be secured between the mechanical and the electric levers.

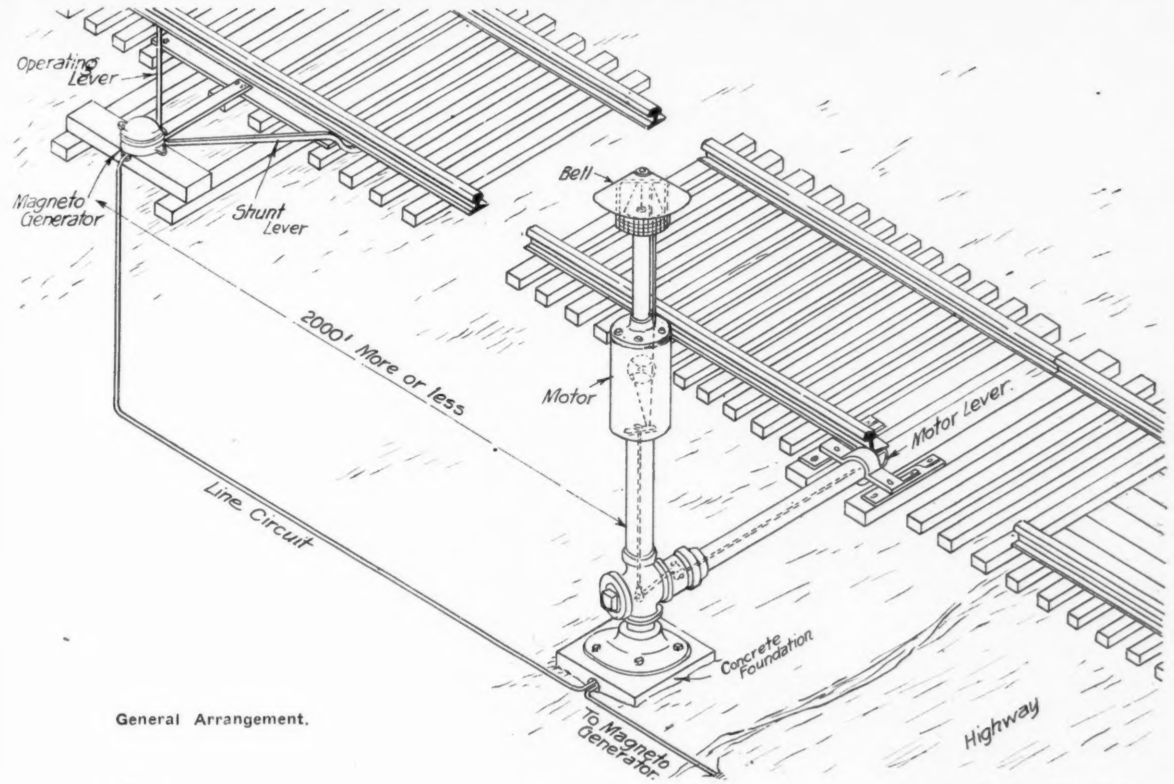
The electric levers with their supports and connections can be applied to existing mechanical machines by revising the locking to suit conditions and inserting the required number of special locking shafts and drivers in the locking bed. The electric levers in the style "S" machine are separate units, capable of being spaced 5 in. between centers. Any number, therefore, not exceeding the capacity of a given mechanical machine frame may be placed above such a machine as desired.

HOESCHEN HIGHWAY CROSSING BELL.

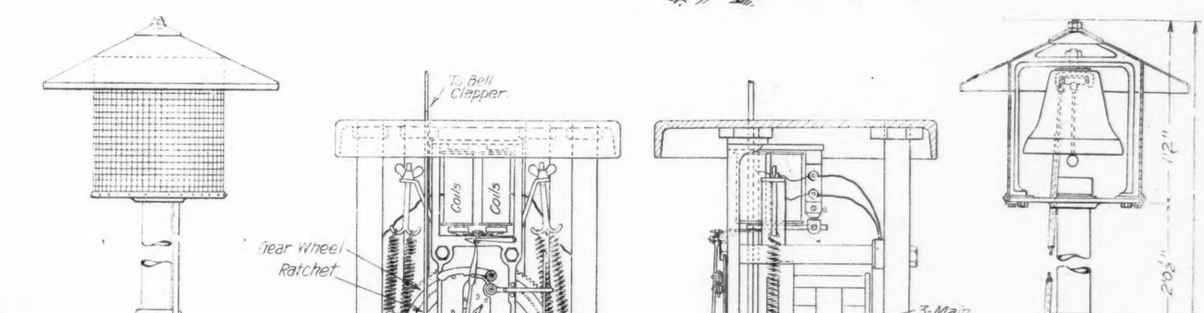
This bell is adaptable to all crossings on either steam or electric roads. No track circuits, batteries, nor other delicate apparatus is used in the operation of this bell. The makers claim that it is easily installed, substantially constructed, and is not affected by weather conditions. Hence the cost of maintenance is reduced to a minimum. The motive power used to operate this bell, is obtained by the depression of the rail. This source of power being absolutely reliable, insures against failures. The first cost compares favorably with that of other bells and numerous installations during the past three years on the C. B. & Q., and more recently of the Union Pacific are said to have proved entirely satisfactory.

Magneto-Mechanical Generator.

A generator shown herewith is placed at the required distance each way from the crossing. This device consists of two levers with their inner ends resting against the under side of the rail and fulcrumed close to it. Their outer ends terminate adjacent to a releasing rod used in connection with an armature resting on the cores of a pair of induction coils fastened to the poles of a group of permanent magnets. When a train is going toward the crossing a slight depression of the rail above the operating lever causes the outer end of this lever to lift the armature from the induction coils. This induces a momentary current which is transmitted by a metallic circuit to the releasing magnets controlling the bell motor, causing the bell to ring until the train reaches the crossing. A train passing in the opposite direction will depress the rail above the shunt lever first, thus causing the outer end of this lever to shift the releasing rod away

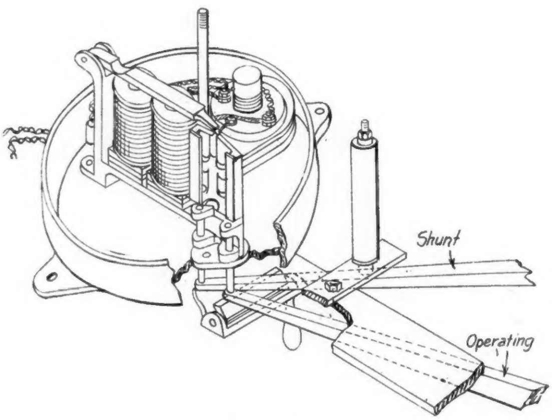


General Arrangement.

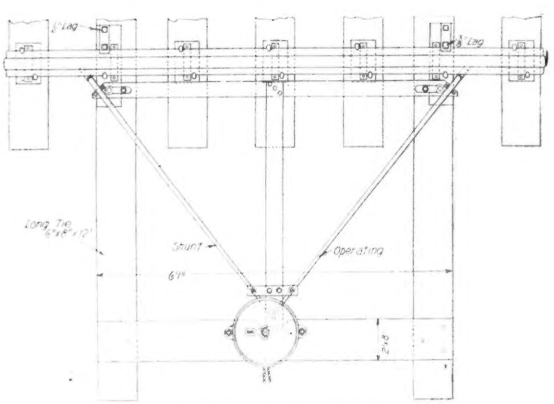


Bell Mechanism.

Generator in Working Position.



Generator.



Generator in Position.

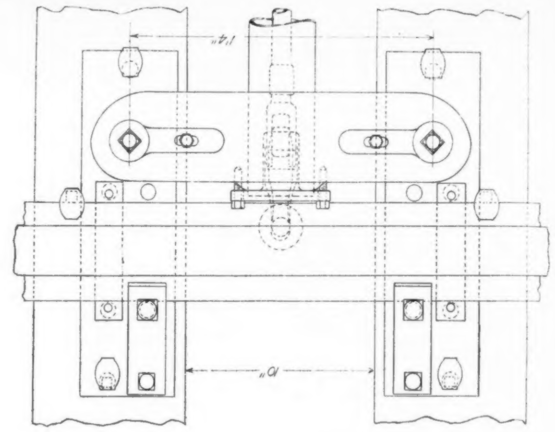
from the armature so that the depression of the operating lever immediately following has no actuating effect.

Motor

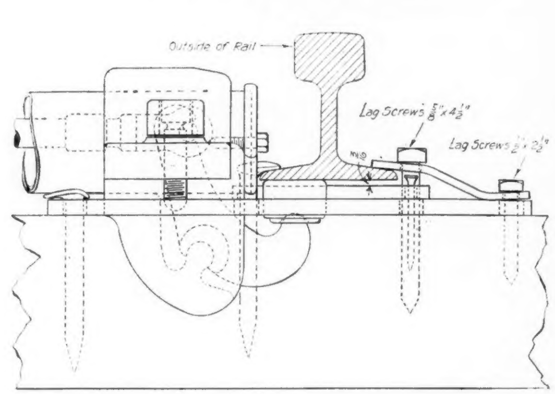
The spring motor used to operate the bell (see cut) is completely enclosed in the metal cylinder on the bell stand. This motor is compactly built and the few parts required for its construction consist of a simple gear movement of three wheels used in connection with three powerful motor springs. These springs are secured to the main driving shaft of the motor and are wound by a rod connected directly with a lever resting against the under side of the rail at a point opposite the motor. When the rail at this point is depressed by the wheel of each car of a passing train, a reciprocating motion of the winding rod is obtained, thus winding the springs and restoring the releasing lever controling the motor, means being provided to prevent overwinding. When the motor is released by an approaching train passing over the generator it actuates a pendelum bell hammer which at regular intervals strikes alternately the inner sides of a loud sounding locomotive type of bell at the rate of 200 strokes per minute until the train reaches the crossing.

This device can also be used for annunciators at interlocking plants.

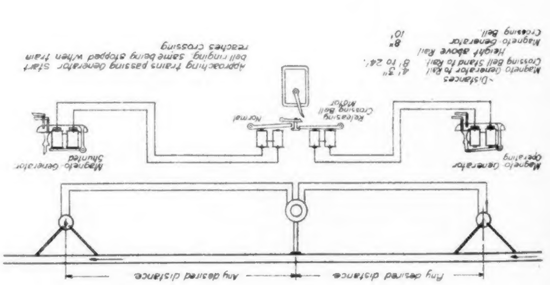
The Hoeschen Manufacturing Co. of Omaha, Nebr., are the makers.



Arrangement of Plates and Shims.



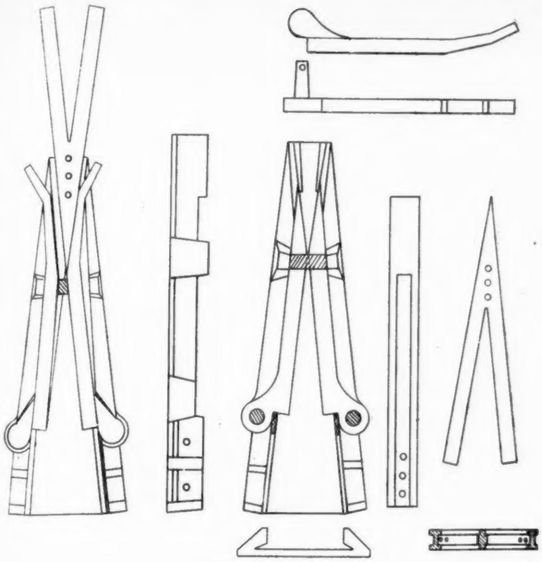
Connection to Rail.



Circuits.

THE MORGAN FROG.

This frog, illustrated herewith, is designed to give a continuous rail, and, the makers claim, is the simplest frog on the market. They say that this frog excels in durability, simplicity and economy and is exceptionally safe and strong. The point, which is detachable, can be used and reversed on either side, thus compensating for wear and giving the frog a very long life. The Morgan frog can be used on either right or left turn-out, this reducing materially the amount of stock necessary to carry, and simplifying the making of requisitions. In renewing the frog the wing rails and point can be installed on an old bed plate, as the bed plate will outwear three sets of points and wing rails. This will effect a marked saving in maintenance cost. These frogs are said to be giving entire satisfaction where installed. The device is made by the Morgan Frog & Crossing Co., of St. Louis, Mo.



Morgan Frog.

B. J. Morgan,
Morgan Frog & Crossing Co.

THE LOUD SPEAKING TELEPHONE.

For years the loud speaking telephone has been the inventor's dream. In the first few years after the telephone was invented, improvements came rapidly. Then, gradually, all the patents were gathered under one control. Elaborate researches produced a number of minor improvements but not for fifteen years has there been any marked improvement in telephone instruments.

HOT-WIRE SYSTEM FOR TUNGSTEN LAMPS.

An ingenious scheme to overcome the brittleness of the tungsten lamp filament when not burning was devised by E. M. Fitz, electrical engineer of the Pennsylvania Lines West of Pittsburg, in which he arranges to have a small current passing through the lamp when extinguished, which has been used by his road with great success. On cars using 63 volts (32 cells) the two end cells of the battery, giving 4 volts, are connected to the lamps when extinguished, which keeps the filaments at a faint dull red and makes them about as rugged as a carbon lamp. The lamps when lighted are connected to the remaining 30 cells, 60 volt lamps (instead of 63) being used. This scheme is known as the "Hot-Wire System," and is being patented. Recent figures show lamp lives of from 1,500 to 2,000 hours by this system.

In practice it is found that the two end cells of the battery are no more exhausted than are the remaining cells, as one would at first suppose. This might occur, however, if the burning hours were very short, the lamps being connected most of the time to the two end cells. On account of the lesser current taken from the end cells it is estimated that the lamps should burn an average of about three or four hours out of the 24 to have all the cells exhausted to the same extent.—From "Train Lighting by Electricity," by Henry Schroeder; Proceedings of the Richmond Railroad Club.

Individual Drive for Small Tools.—Considerable difference of opinion has developed as to the advantages of individual versus group drives for machine tools, and while it is generally agreed that it is advantageous to have the larger tools individually driven, the agreement by no means extends to the smaller ones. Under certain conditions there is no question as to the advantages of the individual drive for small tools, as, for instance, where small tools are necessarily placed among larger ones, or to allow convenient placing of tools in the assembling departments. The cases where it would be advantageous to have small individually-driven tools are numerous.—Chas. Fair, before A. S. M. E. and A. I. E. E.

INDUSTRIAL NOTES.

The G. M. Yost Mfg. Co., Meadville, Pa., has recently installed a lot of new machinery, in order to take care of its increasing business. This company recently bought out the Williamson Vise Co., Bradford Pa., and is making a very complete line of vises for all purposes.

William H. Silverthorn, president of the Railway Steel-Spring Co., died at his home in Painesville, O., Aug. 13. He was 61 years of age and had been ill since last spring. Mr. Silverton was a son of J. H. Silverthorn, who conducted a hotel at Rocky River, near Mentor, O. He gained his early education in the common schools and high school and entered the local shops of the Lake Shore railroad, at Mentor, as a machinist's apprentice. At off hours he learned bookkeeping and, when the Winslow Roofing Co. was organized to manufacture a metal roofing for freight cars, Silverthorn became a traveling salesman for the concern. Later he became connected with the Paige Car Wheel Co., and, when it combined with others into the Steel Car Wheel Co., he became manager of the new company. When the Railway Steel-Spring Co. was organized he was elected president.

The Mexican-Northwestern Railway Company of 25 Broad street, New York, has recently placed a large order for motors with the Westinghouse Electric & Manufacturing Company. The order includes 168 induction motors, aggregating 3,736 h.p., of the types MS and HF, ranging from 3 to 200-h.p. These motors will be shipped to the company's property at Madera, Chihuahua, Mexico, to be used in the operation of the saw and planing mills.

Mr. W. M. Lalor has resigned as manager of the railway department of the United States Light & Heating Co., to accept the position of sales manager of the electrical department of the Gould Coupler Co., with offices in Chicago.

The Chicago Pneumatic Tool Co., 50 Church street, New York city, has recently taken orders for five gasoline-driven air compressors. These machines were sold to structural contractors and are of a type recently perfected by the Chicago company.

The Railway Improvement Co., New York city, has been incorporated to do general contracting, electrical work of all kinds, and mechanical engineering, etc. The incorporators are Rufus L. MacDuffie, 30 Church street, New York City;

Geo. W. Fairchild, Oneonta, N. Y.; A. H. Carlisle, 74 Broadway, New York City. Capital, $100,000.

Hildreth & Co., New York and Chicago, have secured steel inspection contracts on the mill, shop and field work for the Denver post office and court house.

The Chesapeake & Ohio Equipment Corporation, recently organized, has filed at Richmond, Va., a trust agreement conveying to the Mercantile Trust Company of New York rolling stock to a total cost of $5,500,000 as security for $4,-800,000 series A and B, one year, 5 per cent equipment notes to be dated July 1, 1910. None of the notes will be sold at present.

The Hodges-Downey Construction Company, St. Louis, Mo., has received a contract from the St. Louis, Iron Mountain & Southern for the filling of about 20 trestles, approximately 460,000 yards, on the line between McGehee, Ark., and Helena, Ark.

The Safety Foot Guard & Railway Appliance Company, Columbus, Ohio, has been incorporated with a capital stock of $10,000. The incorporators are H. D. Ridenour and others.

The Kellogg Switch & Supply Co., Chicago, has been made exclusive agent of the United States Electric Co., New York, for sale of railway telephone equipments, including the Gill selector.

The Marion Shovel & Dredge Company, Marion, Ohio, has been incorporated with a capital stock of $400,000. The incorporators are J. D. Owens, Arthur E. Cheney, B. K. Evans, C. A. Owens and H. J. Barnhart.

The W. S. Tyler Company, Chicago, has moved its offices from 800 Railway Exchange building to 701 Harvester building.

E. H. Symington has been appointed mechanical expert of the T. H. Symington Co., Baltimore, Md., with headquarters at Chicago.

The Damascus Brake Beam Company will open a plant in Cleveland, Ohio, soon to replace that which was burned a few weeks ago at Sharon, Pa.

The Bucyrus Company, South Milwaukee, Wis., has secured all the rights to manufacture and sell the Heyworth-Newman drag line exacavator, formerly held by James O. Heyworth, of Chicago. A complete line of these excavators will be developed and placed on the market.

The Blue Island Rolling Mill & Car Co., Blue Island, Ill., has leased its property to the Chicago, Rock Island & Pacific. By its terms the Rock Island has rented the property for $2,500 a month, but has the right to purchase the property prior to October 31, 1910, for $150,000.

Dalton Risley, who has been in charge of the railway sales department of the National Refining Co., has resigned this position to accept a position in the railway lubricating department of the Indian Refining Co., with headquarters in Cincinnati. It is doubtful if there is a more popular man in the lubricating business than Mr. Risley. His hosts of friends in the railway and supply field will watch his progress among new associates with interest.

The Burnite Machinery Co., Denver, Colo., reports good success in the sale of the Smith hose clamp tool. This tool which was described in the Railway Master Mechanic, issue of April, 1910, furnishes a convenient and economical method of clamping air and steam hose to fittings. The tool is designed to be carried by shop or outside repair men and the features mentioned have attracted considerable attention on the part of mechanical men.

The Williams All-Service Car Door Company, Clinton, Ill., has been incorporated with a capital stock of $600,000. The incorporators are Walter Scott Williams, Charles R. Westcott and William H. H. Hastings.

Clapp, Norstrom & Riley, general sales agents of the Western Wheeled Scraper Co., Aurora, Ill., and Davenport Locomotive Works, Davenport, Iowa, have purchased a tract of land at Clyde, Ill., where they will build a shop, 60 ft. x 100 ft., to be used for handling stock implements.

The Vulcan Steam Shovel Company, Toledo, Ohio, will build a plant at Evansville, Ind., to cost $200,000.

The Universal Car Seal & Appliance Co., Albany, N. Y., has been incorporated with a capital of $60,000. The incorporators are: Howard Van Renssalaer, William C. Martineau, Clarence R. Martineau.

The Baldwin Locomotive Works have filed papers with the secretary of state of Pennsylvania providing for an issue of $10,000,000 first mortage 30-year bonds to bear interest at 5 per cent. Kuhn, Loeb & Co., New York, and Brown Brothers & Co., Philadelphia have concluded negotiations for the disposal of the entire bond issue. Brown Brothers & Co. recently underwrote a $3,000,000 bond issue for the Standard Steel Works Co., Philadelphia.

The W. H. Coe Mfg. Co., Providence, R. I., sole manufacturer of Coe's Gilding Wheels and Coe's Ribbon Leaf, has recently rearranged its railway department, making E. J. Arlein its western representative with headquarters in Chicago; Benj. A. Smith its eastern representative with headquarters in Philadelphia; and Frank Taylor its special representative with headquarters in New York City. All of these men are well known in the railway world and the new arrangement of territory will enable them to keep in close touch with their friends.

The American Society of Engineering Contractors will hold its annual convention in St. Louis, on Sept. 27, 28 and 29, in the Coliseum. Papers will be delivered by J. B. Goldsborough and Ed. Wegmann, both of New York, on "Dam Construction for City Water Supplies," and by George C. Warren, of Boston, on "Work Preliminary to Street Paving and Road Work." A banquet will be held, and several sight-seeing trips will be made to important engineering work in and around St. Louis.

William J. Ball has been appointed mechanical engineer of the Crawford Locomotive and Car Company, Streator, Ill. Mr. Ball was in the engineering department of the Pullman Company for 12 years. He was mechanical engineer and sales representative of the Bettendorf Axle Company for four and a half years and spent four years in the railway supply business in Seattle, Wash., Portland, Ore., and Chicago. He is thoroughly familiar with the details of car construction, estimating and designing.

The officers of the recently incorporated Williams All Service Car Door Company, Clinton, Ill., are: W. S. Williams, president; C. W. Pifer, vice president; C. R. Westcott, secretary and treasurer. The directors are: W. S. Williams, C. W. Pifer, C. R. Westcott, William H. H. Hastings and Henry C. Koehler.

David W. Pye has been elected president of the United States Light and Heating Company, succeeding William H. Silverthorn.

The Locomotive Superheater Company, 30 Church Street, New York, announces that it has acquired the United States and Canadian rights of what it regards as the basic patents of fire tube superheaters. The patents acquired include the inventions of Wilhelm Schmidt, H. H. Vaughan, A. W. Horsey, Francis J. Cole and others. There are more than 6,000 of these superheaters in successful operation or in course of construction in Europe and over 800 in America. The officers of the company are: President, Wilhelm Schmidt; vice president, Simon Hoffman; secretary, Otto Von Schrenk; treasurer, Samuel G. Allen. The directors include the officers and Fritz Von Briesen, Oscar Gubelman, J. S. Coffin and Le Grand Parish.

Alphabetical Index to Advertisers

Acme Equipment & Eng. Co. 2
Adams & Westlake Co. 12
Brach Supply Co., L. S. 6
Brown Hoisting Mach. Co. 13
Bossert Mfg. Co., W. F. 9
Booth, L. M. & Co. 8
Bowser Co., S. F. 3
Cincinnati Frog & Switch Co. .... Front cover
Coes Wrench Co. 7
Cleveland City Forge & Iron Co. .... Front cover
Dayton Iron Works Co., The 3
Dilworth, Porter & Co. 16
Dixon Crucible Co., Jos. 9
Electric Railway Equipment Co. 13
Fairbanks, Morse & Co. 12
Foster, Frank M. 6
Franklin Mfg. Co. .... Front cover
Galena Signal Oil Co. .... Front cover
Galion Iron Works Co. 12
Gray, Peter & Sons 2
Groff Drill & Machine Co. 14
Hardmuth, L. & C. 6
Hart Steel Co. .... Front cover
Hicks Loco. & Car Works 5
Hubbard & Co. .... Front cover
Hurley Track Laying Mach. Co. 5
Indianapolis Switch & Frog Co. 16
Industrial Supply & Equip. Co. 14
Interlocking Nut & Bolt Co. 9
Johnson Wrecking Frog Co. 5
Light Inspection Car Co. 12
Mann-McCann Co. 13
Marsh Co. 15
Mechanical Mfg. Co. 9
National Indicator Co. 2
Otto Gas Engine Works 3
Philadelphia Turntable Co. 5
Rabok Mfg. Co. 2
Rail Joint Co. 6
Railway Specialties Co. 4
Railway & Traction Supply Co. 2
St. Louis Surfacer & Paint Co. .... Front cover
Seelig & Son, R. 3
Troutwine, John C. 4
Van Nostrand Co., D. 7
Watson-Stillman Co., The 7
Wiley & Sons, John 4
Williams Co., G. H., The 15
Wyoming Shovel Co. 7

r, 1910

t

d.

ES

NY